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ABSTRACT

This magazine is designed for teachers and students in junior and senior high schools. It is intended to help students become more aware about what scientists and engineers do, what's new and exciting in the fields of science and engineering, and what satisfactions might be expected from a career in one of the many different areas of science and engineering. It contains descriptions of 10 disciplines with short autobiographical statements prepared by scientists or engineers in that discipline. These disciplines are: anatomy (Eldridge F. Johnson); biochemistry (John Law, Franklin D. Hamilton, Bradley T. Sheares, Robert Barker, and John Pierce); biology (Clarice Gaylord, Clifton Poodry, Evelyn Rivera, and DeLill Nasser); chemistry (Bert Fraser-Reid, Henry Taube, Anne Swanson, and Ignacio Tinoco); engineering (John Slaughter and Robert V. Edwards); microbiology (Ramon Pinon, Gerald V. Stokes, and Keith R. Yamamoto); pathology (Eugene W. Adams and Tracie E. Bunton); pharmacology (Yvonne Clement-Courmier, Janice Stickney, Paul Sato, and Stuart Taylor); physics (Homer Neal, Walter Massey, Michael Nieto, and Eugene Tademaru; and physiology (Sarah Gray). A special feature on women and minorities in space is included, with statements prepared by Sally Ride, Guy Bluford, and Franklin Chang-Diaz. (JN)

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SCIENCE
Career Magazine

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Feature Interview: NASA—
WOMEN AND MINORITIES IN SPACE

Inside:

THOSE "-OLOGIES"
What do they mean?

WHAT AM I DOING HERE?
30 scientists tell why they chose science as a career.

SE 046002

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"Tomorrow's Scientists are in Today's Schools"

— National Science Foundation

This magazine is for teachers and students in junior and senior high schools. It is intended to help students become more aware about what scientists and engineers do, what's new and exciting, and what satisfactions might be expected from a career in one of the many different areas of science and engineering. Parents are a critical element in that they provide guidance to their children throughout the educational process. This magazine is also intended for them.

It would be difficult to include all of the sciences in one magazine. An attempt has been made in this magazine to describe different kinds of physical and biological sciences, and two of several kinds of engineering. There are many additional science areas such as mathematics and computer science, geology and archaeology, sociology, psychology, medicine and other health sciences, and legal aspects of science and the administration of science. Additional sources of information about these other career opportunities can be found in the bibliography of resource materials.

Dr. Iris Weiss of the Research Triangle Institute has summarized some important aspects in the choice of science or engineering as a career. These factors, given below, are exemplified in the profiles in this magazine.

Tomorrow's world will be shaped by the knowledge that you can add to help improve society's needs in agriculture, medicine, the environment, leisure time activities, and the arts and humanities. Won't you please consider science or engineering as a career? Isn't it the challenge you have been looking for?

- *There is a diversity of science and technology careers requiring different kinds of skills and different levels of training and education.*
- *Successful science careers can be combined with full personal lives; women need not give up marriage and motherhood to pursue these careers.*
- *There is a variety of resources available for learning more about specific science and technology careers.*
- *One does not need to be a genius to succeed in a career in science and technology.*
- *The ability to be a successful scientist is not restricted to any one race or sex.*
- *Students need not decide on a particular career at this stage but should begin thinking about various alternatives.*
- *It is especially important for students to keep their options open by getting a good background in science and mathematics.*

Career Magazine

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What is... ANATOMY

The anatomist is a scientist who investigates cells, organs and organisms and asks "How is it made?" and "What does it do?" Anatomy is basic to medical and health-related professions and is interdisciplinary by nature. Undergraduate education for aspiring anatomists is broadly based and may include anthropology, chemistry, physics, mathematics and behavioral sciences. Graduate studies usually include three to five years of gross anatomy, cell biology, histology, neuroanatomy, and embryology supplemented by biochemistry, physiology, immunology, genetics, and pathology. The modern anatomist functions as a teacher and a researcher. As a teacher, the anatomist helps train students in the health sciences and also provides advanced training for teachers and researchers. As a researcher, the anatomist uses sophisticated techniques and instruments such as electron microscopy, immunocytochemistry, tissue culture, and autoradiography to help advance knowledge of biological structure and function. The anatomist's role as a researcher is fundamental to future scientific discovery in areas such as aging, cancer, neurobiology, immunology, and reproductive biology.

High power scanning electron micrograph (SEM) of the surface of a bronchiole. Hair-like cilia can be seen between the domed cells called clara cells. 3000x.
Courtesy Dr. L.M. Ross, Department of Anatomy, Michigan State University

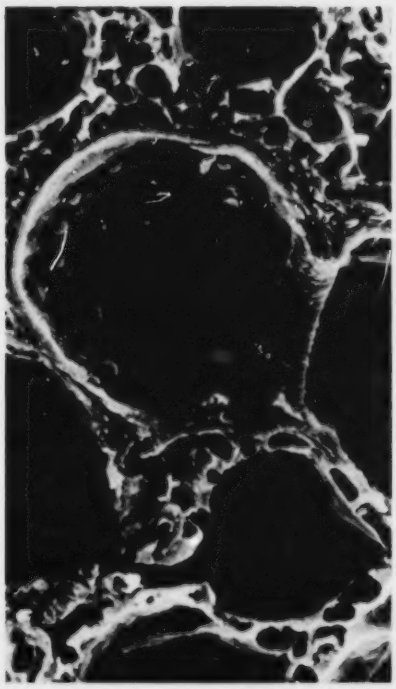
Eldridge F. Johnson

Anatomy

Birthplace
Birmingham, Alabama

Education
B.A., Miles College, 1963.
Biology
M.S., Atlanta University, 1965.
Zoology
Ph.D., University of Alabama, 1972, Neuroembryology

Present Position
Assistant Professor of Anatomy
The University of Tennessee



Higher power SEM showing a blood vessel at left center. Alveoli have been exposed to the right and the lumen of numerous capillaries are visible between the alveoli. 500x.

I grew up in a suburb of Birmingham, Alabama during the post-World War II era. As far back as I can remember, I have been intrigued by living things and the structural mechanisms that facilitate their day-to-day activities. I became a boy scout in elementary school and this activity provided the opportunity for me to spend many enjoyable hours observing insects, fish, reptiles, birds, and small mammals in their natural habitats.

I participated in several science fairs during high school, and the constant desire to understand the biophysical world was only abated by constantly reading science textbooks and journals.

Although my high school activities were centered in a modern industrial metropolitan community, Birmingham continued to possess a strong rural flavor. Many of the men in my immediate neighborhood worked in the steel mills for their primary livelihood; however, they continued to raise livestock and gardens. One of my most impressionable memories was of the annual livestock slaughter that usually followed the first fall frost. This early exposure stimulated within me a lifelong inquisitiveness and fascination of animal morphology, the diversity of living forms and the orderly relationship of cells, tissues, and organ-systems.

This concern was responsible for my pursuit and completion of a Bachelor of Arts degree in Biology, a Master of Science degree in Zoology and a focus on human structure, and the earning of the Ph.D. degree in Human Anatomy.

Being an anatomist involves teaching human morphology and researching various problems concerning human structure. My profession has given me the following opportunities: (1) to contribute to the education of hundreds of medical and paramedical professionals, (2) to become internationally recognized as a contributor to a body of knowledge (the structure and function of the intervertebral disc), (3) to be assured financial security, and (4) to have the respect and admiration that are afforded a university professor.

"As far back as I can remember, I have been intrigued by living things."

What is... BIOCHEMISTRY

3T3 Fibroblasts illuminated by an argon laser after staining with acridine orange (green and yellow mark nuclei; red dots are lysosomes). Magnified 800x

Biochemistry is one of the sciences that concerns the chemistry of living things. Laboratory experiments are undertaken to determine the chemical composition of living organisms, the organization of chemical activities within their cells, and how these activities are related to movement, sensation, thought and learning, reproduction, and the conversion of the energy of foods to forms that can be directly used by cells. Biochemists are interested in all kinds of life, from simple viruses and bacteria to insects, plants and people. Exciting new areas of research include such problems as how genes are made and how they function, how chemicals and viruses cause cancer, how enzymes can be made to work in large industrial-scale processes, how drugs affect reactions in a cell, and how the growth, division and life-span of cells are regulated.

Students who wish to consider a career in biochemistry should learn as much math, chemistry, physics and biology as they can in high school. Further training in a university provides the overall background and laboratory experience needed for original research in biochemistry. There are still many unanswered questions, both fundamental and directed, about life and biochemistry is one of the disciplines which can be used to find the answers.

John H. Law

Biochemistry of Insects

Birthplace
Cleveland, Ohio

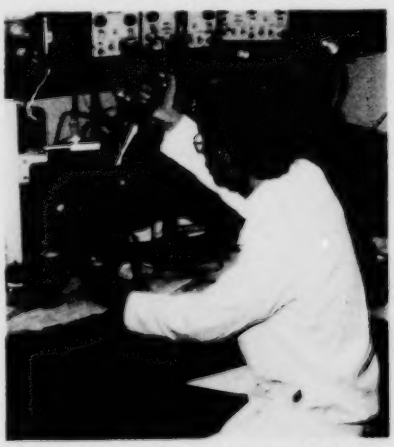
Education
B.S., Case Institute of Technology, 1953, Chemistry
Ph.D., University of Illinois, 1957, Biochemistry

Present Position
Professor and Head of the Biochemistry Department, University of Arizona

Honors
Tau Beta Pi
Sigma Xi

Research assistant micropipetting in a radioactive safe area.

Physiology graduate student using Langendorff apparatus for studying coronary blood flow.



Graduate student in pharmacology using an isolated tissue organ bath, which measures contractions of cardiac tissues.

At the age of eight I decided to become a marine biologist. I would probably have done so, had it not been for the intervention of a high school counselor, who persuaded me there was no future in it; in retrospect, it is easy to see how wrong that advice was. At any rate he sent me off to be an engineer. From there I worked my way into organic chemistry, biochemistry and have now ended up somewhere near my original goal, studying the biochemistry and physiology of insects. In all of this transition I have always found enjoyment in what I was doing, and always marveled that someone would pay me to do a job I loved.

An important part of the fun of doing science is the excitement of spotting something no one else has ever seen before. The feeling must be akin to that musicians and artists have when they create something new. The excitement is infectious, and soon everyone in the lab is caught up in speculation about what this new observation can mean. Standing next to someone who makes a major find is the next best thing to making it yourself.

"The excitement is infectious."

An important aspect of scientific investigation is the opportunity it offers to work with others. This, in turn, often leads to travel and a chance to see how others do things in a different environment. My studies have taken me all over the world, and I currently collaborate with scientists in China, India and Kenya.

Franklin D. Hamilton

Enzymology and Molecular Biology of DNA Replication

Birthplace
Aucilla, Florida

Education
B.S., Florida A & M University, 1964, Chemistry and Biology
Ph.D., University of Pittsburgh, 1969, Biochemistry

Present Position
Associate Professor of Chemistry, Atlanta University

Honors
USPH Postdoctoral Fellow (1969-1970)

My chosen area of research is in the field of biochemistry. In my initial lecture to the biochemistry class that I teach to a mixture of biology and chemistry students, I begin with the statement: "Biology is Chemistry." This perturbs both the biology and chemistry students and is therefore good for its "shock value." But it is a very accurate statement . . . and for me, provides for the excitement and enthusiasm I experience in the profession as a research scientist. We can look at any biological function, for example, transformation of food into energy, locomotion, cell division; each of these events can be explained in terms of chemical reactions. Current research activities support the contention that even alterations in mental states in humans may result from changes in certain levels of chemicals in the brain. Perhaps one day we will be able to explain memory as a combination of chemical and electrical processes that take place in the brain. This is exciting to think about!

"I gain a sense of accomplishment as I work with students and observe them as they achieve their career objectives."

It must be obvious at this point that I have a keen interest in asking the question "How does an event occur" or "What causes an action to take place" as such activities relate to biological systems. I then initiate an orderly, logical approach to finding an answer. This is the fundamental process that is used by all scientists. If you have a natural curiosity about how things work, you should consider science as a career.

I also enjoy working with students, assisting them in developing their skills to embark upon scientific careers. For that reason, I have worked in an academic community since receiving my degree. I gain a sense of accomplishment as I work with students and observe them as they achieve their career objectives. This is the reward of teaching. In addition, there is one thing that I learned as a biologist that is very important to me as a scientist: procreation is necessary for the survival of species. In this vein, the teaching of science to students ensures an adequate supply of scientists for the future.

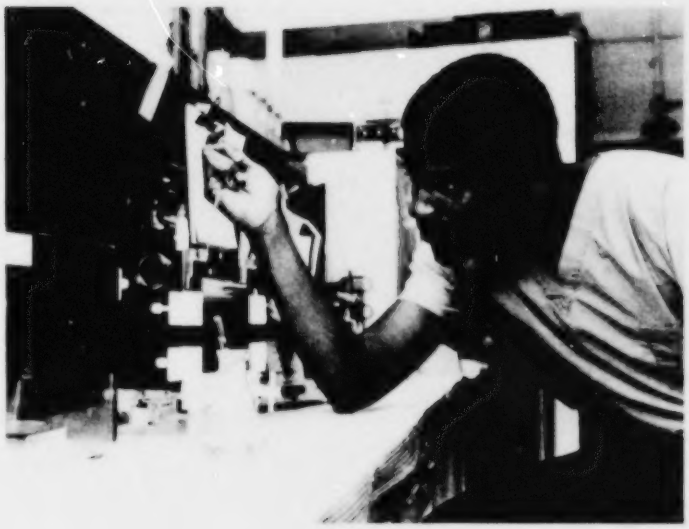
Bradley Sheares

Surface Biochemistry of Cell Glycoconjugates

I initially became interested in science as a high school senior. I was intrigued by laboratory demonstrations, especially those in biology and chemistry. Although I believed, as many high school students do, that science is hard, I have found that interest is the most important factor in determining how well a student will fare in science. When students are interested in science they find it is not as difficult as many would have them believe. Mathematical concepts, biological processes and chemical formulas are not any harder to learn than the words to a song, a combination to a lock or a script to a play. To master science one must practice. One cannot learn to master a musical instrument, a sport or chemistry with only occasional practice. One becomes a polished musician, an award-winning athelete or a good chemist by working hard and practicing often. I do not believe students exist who cannot master science if they are interested and if they are willing to practice.

"Interest is the most important factor in determining how well a student will fare in science."

Science is a broad field that allows individuals to find and pursue areas that interest them. I encourage students to consider careers in science. As the world continues to become more technically oriented, individuals trained in science will be able to pursue careers in government agencies, universities, colleges and other educational institutions as well as in private industry.



Birthplace
Batavia, New York

Education
B.S., Fisk University, 1978; Chemistry
Ph.D., Purdue University, 1983; Biochemistry

Present Position
Research Associate in Cancer Biology, Massachusetts Institute of Technology

Honors
American Cancer Society Postdoctoral Fellowship (1983-1985)
Outstanding Young Men in America (1981)
Phi Beta Kappa
Gamma Sigma Delta
Beta Kappa Chi
Danforth Fellow

Cell sorter (cytofluorograf) can look at size of cells, can sort cells for specific populations, can analyze markers such as fluorescent labels to see if the cells have picked them up.

Robert Barker

Bioorganic Chemistry, Biochemistry of Carbohydrates, Science Administration

Birthplace
Bedlington, England

Education
B.A., University of British Columbia, 1952, Biology
M.A., University of British Columbia, 1953, Biology
Ph.D., University of California, Berkeley, 1958, Biochemistry

Present Position
Vice President for Research and Advanced Studies, Cornell University

Honors
Sponsor of the Graduating Class, College of Osteopathic Medicine, Michigan State University
Special Fellowship, NIGMS, NIH (1970-1971)
Career Development Award, NIGMS, NIH (1963-1970)
Teacher of the Year, College of Medicine (1968)
Sponsor of the Graduating Class, College of Dentistry, University of Tennessee (1962)
Atlas Powder Company Postdoctoral Fellowship, Washington University

It took me a long time to realize that there was more to science than learning what was already known. Realization that less was known than remained to be discovered came slowly and as something of a surprise during my last year in college.

I was born on the outskirts of a mining town in the north of England and grew up with mine heaps on one side and farms on the other. There was never any doubt that my interests lay with the farms. After high school I intended to study agriculture and become a farm manager. I did work on a farm and then emigrated to Canada where I spent two years working as a logger. Besides learning to curse in several languages, I learned that ignorance was not bliss and began study at the University of British Columbia. By now my thoughts had turned to medicine and I began a course in biology. My interests gradually turned from the variety of nature to curiosity about how things worked. Courses in embryology, genetics and physiology fed my curiosity and when I was a senior I began a research project on the effects of nicotine and caffeine on blood pressure in the rat. Even at this point I was only vaguely aware that I might be studying something no one else had ever studied and that I might add new knowledge to what seemed like a vast accumulation in the library. It was only when I began to try to find an explanation for my observations that I began to realize how little was known and to understand that all of biology was determined by the chemistry of living things. That was thirty years ago. The situation today is different, but we have still only scratched the surface of what there is to know about biology or for that matter most of the sciences.

"We have still only scratched the surface of what there is to know about biology."

Realization of the vastness of our ignorance and of the pleasure that comes from making even small contributions to our knowledge and understanding of the world led me to graduate study in biochemistry and a thoroughly enjoyable career trying to understand the chemistry of carbohydrates.

There are other pleasures. The excitement of research shared with students and colleagues. Teaching and writing so that others can begin to see the marvelous logic and the efficient simplicity behind the complex events of nature also bring a sense of accomplishment.

John Pierce

Enzymology, Photosynthesis

My work involves trying to understand the way in which plants and micro-organisms fix carbon dioxide from the atmosphere and convert it into sugars and starches that they can use as food sources. The efficiency of this process determines how well and at what rate plants can grow. From a practical viewpoint, increasing the efficiency of carbon dioxide fixation may allow us to produce new breeds of faster and larger growing plants to meet the increasing nutritional needs of a growing planet.

I find the rewards of research to be deeply satisfying. Everyday, I must use my training and analytical abilities to solve a variety of complex puzzles. Research can be so engrossing, that it provides a nice "vacation" from the everyday chores of life.

Scientific training provides more than a career. It provides a basis for understanding your natural environment and the dramatic scientific and technological advances that occur continuously. It is a joy to know, even if only in a general sense, how televisions and computers work; what an X-ray is; why the sky is blue; how muscles work.

It has been said that the most amazing thing about Nature is that it can be understood at all. When you participate in trying to understand the nature of things, the world becomes vast and fascinating, and your life is enriched. I know of no better way to participate than through scientific study.

"When you participate in trying to understand the nature of things, the world becomes vast and fascinating, and your life is enriched."

Birthplace
Monmouth, New Jersey

Education
B.S., Pennsylvania State University, 1976, Biochemistry
Ph.D., Michigan State University, 1980, Biochemistry

Present Position
Staff Scientist, Central Research Department, E.I. DuPont de Nemours & Company

Other Sources and Resources

Women and Minorities In Science and Engineering

Science Careers Program

The Research Triangle Institute in North Carolina has developed a Science Careers Program, aimed at increasing the career relevance of science education for all students, while at the same time particularly encouraging female and minority students and handicappers to consider careers in science and technology. This program was developed with the support of the National Science Foundation.

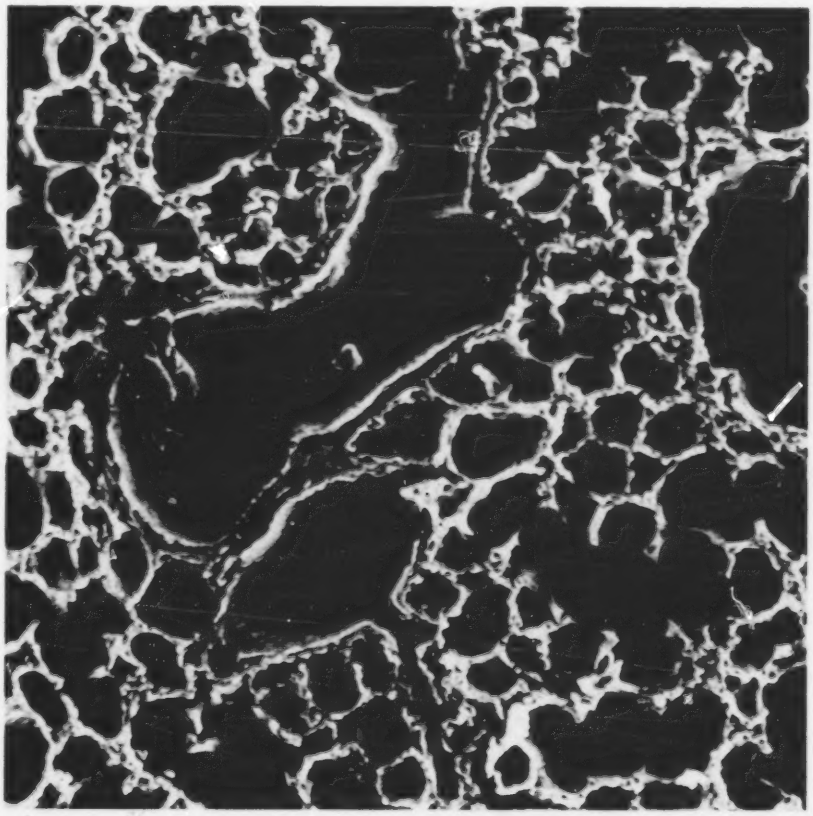
The program consists of 12 class activities, each with brief background information for teachers and detailed guidelines for use of the activity. A filmstrip/cassette presentation, "Exploring Careers in Science and Engineering," and posters of "typical" scientists, including males and females of varying race/ethnic backgrounds, ages, and fields, are used together to help show students the diversity of scientists and science careers. Resource materials for teachers include articles on sex, race, and handicapper role stereotyping; a compendium of famous women and minority scientists; detailed information about science and engineering careers (e.g., definitions of science fields, numbers employed, employment outlook, and salaries); and an annotated bibliography of additional resources. Cont. pg. 14

What is... BIOLOGY

Biology involves both plant and animal sciences. These include the study of animal and plant morphology, function, and behavior. That is to say, we consider how animals are built, how they work, and how they behave. The field includes an array of subareas such as evolution, behavior ecology, genetics, physiology, developmental biology, and vertebrate and invertebrate biology. Activities of biologists involve both laboratory and field studies. Many research and teaching opportunities allow people to work with live animals and free ranging populations in their native environments. Biologists often travel to exotic regions of the earth like the arctic tundra and the tropical rainforests to study unique species of animals.

An undergraduate degree in biology is often used as preprofessional training for individuals who wish to continue their education in medical, dental, or graduate schools. These professional degrees allow a wide range of employment opportunities in both the public and private sectors of our economy, including jobs as doctors, dentists, veterinarians, and researchers, or teachers in educational institutions, industries and governmental agencies.

- *Students finishing their schooling with a B.S. degree in biology may find employment in teaching or research areas as well. They may teach in elementary or high schools, work as laboratory technicians, field research assistants, or as sales representatives for a variety of private industries. Either way, a degree in biology provides an opportunity to do work involved with varying aspects of biology and under a wide array of environmental conditions.*



Low power scanning electron micrograph of rat lung. Magnified 100x

Clarice E. Gaylord

Science Administration

Birthplace
Los Angeles, California

Education
B.S., University of California, Los Angeles, 1965, Zoology
M.S., Howard University, 1967, Zoology
Ph.D., Howard University, 1971, Zoology

Present Position
Executive Secretary, Pathobiochemistry Study Section, National Institutes of Health

Honors
Sigma Xi
Beta Kappa Chi

As an Executive Secretary of a Study Section at the National Institutes of Health (NIH), I am responsible for setting up and conducting scientific merit reviews of grant applications concerned with the biochemistry of disease processes. A major portion of my work involves recruiting scientists from various disciplines to give opinions on the value of research grant applications submitted to NIH. After recruitment of experts in the field, I set up panel reviews, conduct the meeting with an appointed chairman, and document the scientific evaluations of an applicant's work in a summary statement. After each review meeting, I attend Institute Council and Board Meetings and am prepared to address any questions about the reviews. I also spend a great deal of time advising applicants, university administrators, etc., about how the NIH review process works. I attend scientific meetings and occasionally organize (with my study section) workshops to keep abreast of the latest scientific developments in the field.

"Strive to always improve yourself."

I consider my occupation as one of the alternate careers in science. Although I'm required to do a lot of writing, I find the work of a federal health administrator at times to be very exciting and fulfilling. I come in contact with some of the world's leading scientists on a regular basis. I have met and worked with several Nobel laureates and famous medical researchers. There is also an advantage of working at and representing the world renowned National Institutes of Health and being an employee of this complex institution. I have the opportunity to attend numerous lectures and seminars on the latest breakthroughs in medical science technology. The pay is very good and the benefits are many. For instance, I have the opportunity to travel quite often as a government official to major universities, medical institutions and scientific meetings to explain NIH's policies and procedures for securing research support funds. I'm often invited to attend and participate on panels to speak to researchers seeking information about the NIH review process. I also do active recruiting for minority and women scientists for NIH. A word to minority youths — always strive to obtain the best education and job opportunities available and live by constantly striving to meet goals which will improve your quality of life. Prepare yourself by having alternate career choices just in case your original career paths become blocked. Strive to always improve yourself.

Zoology professor with several apple maggot flies; he is studying the genetics of host fruit selection.

Clifton A. Poodry (Seneca)

Developmental Genetics

Birthplace
Buffalo, New York

Education
B.A., State University New York, Buffalo, 1965, Biology
M.A., State University New York, Buffalo, 1968, Biology
Ph.D., Case Western Reserve University, 1971, Developmental Biology

Present Position
Professor of Biology, University of California, Santa Cruz
Program Director, Developmental Biology Program, National Science Foundation

Research is a treasure hunt in search of the nuggets which piece together the great puzzle of understanding life processes. I take great joy in seeing, recognizing or understanding something that has been missed or overlooked by others. The process of discovery is exciting! Research involves more than just exploring the frontier of new knowledge. It requires judgment to define what is important and worthy of investigation.

"I take great joy in seeing, recognizing or understanding something that has been missed or overlooked by others."

Teaching, a central activity in a professor's life, is invigorating and also demanding. There is a satisfaction, even excitement, in sharing the knowledge and thinking with my students. It is a constant learning endeavor to understand and then to convey the material that I determine is important for students to know. Again, judgment of just what is important is a key part of the process.

Being a professor provides the opportunity (and responsibility) for public service. Whether serving on administrative committees, being a consultant to government agencies or formulating and teaching in special programs, there are more ways to be of service than days in the week.

Being Indian and having been raised on a reservation, I always look for ways to help my people and all disadvantaged people. I have often struggled with the desire to provide direct contact, immediate service such as would be provided by a health professional or lawyer. However, I believe that by doing good research and by teaching the next generation of students (and future doctors and lawyers) that the impact of my work will be long term, extending into the next century.

Women and Minorities In Science And Engineering

Cont. from page 11

The Science Careers Program helps teachers to (1) learn about science and engineering career opportunities and where to go for additional information; (2) understand the reasons why there are so few women and minorities in these careers; (3) integrate science career exploration activities into the existing curriculum; and (4) provide additional encouragement for female and minority students and handicappers to pursue science and engineering careers.

While the Science Careers Program was designed for the junior high school level, many of the materials are appropriate for use at the high school level as well. The class activities booklet, filmstrip/cassette presentation, resource materials for teachers booklet, poster set 1 (grades 4-9) and poster set 2 (grades 8-12) are available for $15 for each complete set. Checks or purchase orders should be sent to the Science Careers Program, Attn.: Dr. Iris Weiss, Research Triangle Institute, P.O. Box 12194, Research Triangle Park, NC 27709.

EQUALS Program

The EQUALS program at the Lawrence Hall of Science, University of California at Berkeley, provides materials to assist students and teachers in getting information about careers in science. To obtain these materials, write to:

Dr. Nancy Kreinberg, Director
EQUALS
Lawrence Hall of Science
University of California
Berkeley, CA 94720
(415) 642-1823

SPACES Programs

SPACES is a series of six 30-minute television programs introducing young people of ages 9-13 to people and careers in science and technology. It was produced for Public Broadcasting by WETA in

Washington, D.C. in association with Interamerica Research Associates. Funding was provided by the U.S. Department of Education and the Office of Educational Research and Improvement, with additional support from the Alcoa Foundation. A Teacher's Guide is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 ($4.25/copy or 25% discount for 100 or more copies).

Selected References

- *Nancy Kreinberg, "I'm Madly in Love with Electricity," (1977) Lawrence Hall of Science, University of California, Berkeley, CA 94720 ($2.00).*

This is an excellent source of personal comments of women in science and engineering and contains names and addresses of resource people in various disciplines.

- *Betty M. Vetter and Eleanor L. Babco, "Professional Women and Minorities – A Manpower Data Resource Service," 2nd Edition (1978) with 1980 supplement, Scientific Manpower Commission, 1776 Massachusetts Avenue NW, Washington, D.C. 20036 ($60.00).*
- *"Wanted: More Women in Science and Technology," The Committee on the Status of Women in Physics, (1981), American Physical Society, 335 East 45th Street, New York, NY 10017 ($3.00).*
- *"Engineering a Future – A Guide to Engineering for Parents and Counselors" (1978), National Action Council for Minorities in Engineering, Inc. (NACME), 3 West 35th Street, New York, NY 10001 ($0.50).*
- *"Careers in Biology," Education Department, American Institute of Biological Sciences, 1401 Wilson Boulevard, Arlington, VA 22209 ($0.75).*
- *"Careers in Health," National Health Council, Inc., 70 West 40th Street, New York, NY 10018 ($0.15).*
- *"Careers in Chemistry – Opportunities for Minorities," American Chemical Society, Department of Educational Activities, 1155 Sixteenth Street, NW, Washington, DC 20036 ($0.20).*

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Evelyn M. Rivera

Endocrinology and Tumor Biology

Birthplace
Hollister, California

Education
A.B., University of California, Berkeley, 1952, Zoology
M.A., University of California, Berkeley, 1960, Zoology
Ph.D., University of California, Berkeley, 1963, Zoology

Present Position
Professor of Zoology, Michigan State University

Honors
NIH Research Career Development Award (1967-1972)
American Cancer Society Postdoctoral Fellowship (1963-1965)

I became interested in science in high school, where three teachers of biology, mathematics, and English, respectively, had a special influence on me. They were all demanding and challenging compared to other teachers. The biology teacher stimulated my fascination with living things; the mathematics teacher introduced me to logical thinking; the English teacher taught me how to write good essays and gave me a feeling for critical analysis. What I learned from these three individuals carried me through college and later years. The lessons they taught were not that different and had I not been so fascinated by living things, I would have studied for a career in mathematics or English. Indeed, writing good English is a scientist's responsibility, for not only must many of us write constantly for research funds, fellowships, etc., we must also communicate what we have discovered in our research by publishing regularly in various journals.

"There are a variety of career opportunities for biological scientists."

As indicated elsewhere in this magazine, there are a variety of career opportunities for biological scientists and increasing possibilities for mobility within and between different types of institutions. In my case, being in a university is well suited to my life style, my teaching of endocrinology, and my research on the question of how a normal cell becomes a cancer cell.

DeLill Nasser Science Administration in Genetics

My parents were immigrants. My mother came from Italy; my father from Syria. Incredibly, they met and married in Terre Haute, Indiana, where my two sisters, one brother and I were born. Life was not different for us than for my many cousins except for two things. One was that we were not really part of any community, even the large Syrian community because of my mother's nationality, and the other was the unquestioned assumption that we would obtain a college degree. And so, I did receive my B.S. from Indiana State Teachers College located in Terre Haute. Only by living at home and working summers could I even afford that. After college, I worked for two years at Campbell Soup Co., again in Terre Haute, as a laboratory technician and eventually laboratory manager. Boredom with that job necessitated finding alternatives. When I found that Purdue University would actually pay me as a teaching assistant while I studied for a M.S. degree I left. I received my M.S. in microbiology and took a job with Eli Lilly and Co. in Indianapolis, Indiana.

"I watch the human mind not only answer questions about life, but find the right questions to ask."

I was a research technician but shortly after I arrived the head of the laboratory left and for most of my tenure at Lilly I was in charge of a laboratory primarily concerned with research into the improvement of antibiotics. My efforts were recognized by the fact that I was the first non-Ph.D. to receive a cash bonus based upon the company's profits for that year.

My taste of higher things took me back to Purdue for a Ph.D. but financial considerations mandated that I accept their offer of an instructorship which slowed my progress towards the degree. When I did obtain my degree in 1963, I went to the University of Washington for a postdoctorate with Dr. Eugene Nester on aromatic amino acid metabolism in *Bacillus subtilis*. The work was exciting and I loved the geographical area, so it was with regret that I finally accepted a position at the University of Florida as an assistant professor. Within the four years that I was there I became a tenured associate professor and matriculated one Ph.D. student and two M.S. students. I married, moved to University of California at San Francisco and worked with my husband for several years, mostly with eucaryotic systems. For personal reasons, I came to Washington, D.C. as an associate program officer for the Genetic Biology Program at the National Science Foundation.

My life in science has been exciting, interesting and fulfilling. In fact, I am sometimes amazed that I am actually paid to live in an everchanging, constantly interesting world filled with challenging people. It is with the same awe that others watch sunsets or listen to symphonies, that I watch the human mind not only answer questions about life, but find the right questions to ask. It is somehow reassuring to realize that there will always be someone to ask questions and find answers as long as our species survives.

PHOTOGRAPH BY CHASE, WASHINGTON, D.C.

Birthplace
Terre Haute, Indiana

Education
B.S., Indiana State Teachers College, 1950, Biology and Speech
M.S., Purdue University, 1955, Microbiology
Ph.D., Purdue University, 1963, Microbiology

Present Position
Associate Director, Genetics Division, National Science Foundation

What is... CHEMISTRY

Chemistry professor examining an enzyme three-dimensional structure derived using x-ray diffraction methods.

Chemists are concerned with substances; and among their major concerns, three stand out. First, they make substances, such as plastics, drugs, textiles, soaps, paints, adhesives, insecticides, cosmetics, food additives, petroleum products, and many others. Second, they study the structure and properties of substances and how and why they change from one form into another. The better they understand these issues, the easier it is to make new and improved substances. Third, they analyze substances to find out how pure they are. Thus, they constantly develop new methods to detect trace impurities. These methods require the use of new and complex instruments most of which are controlled by computers.

Chemists work in university and government laboratories and in most of the industries of the world. Every educated person should have some knowledge of chemistry, as many interesting and rewarding careers require varying degrees of training in this field.

Bert Fraser-Reid Synthetic Organic Chemistry

My research is concerned primarily with laboratory syntheses of a variety of organic compounds of medicinal importance, anticancer agents, antibiotics, etc. I supervise a team of 14 scientists including Ph.D. candidates, post Ph.D. scholars and visiting professors. My financial support comes from various federal agencies as well as from private pharmaceutical companies. I do not know whether or not I would be considered a success, but I do consider myself immensely fortunate in that my work is, in a large part, also my hobby and yet I am able to earn an extremely good salary doing it — not as much as my boyhood companion who is an M.D., but my work, unlike his, has taken me to countries as distant as Russia and South Africa, Spain and Japan, Sri Lanka, and Sweden — at the expense of the host country at that.

This is very heavy stuff for someone who grew up barefooted in the hills of Jamaica, and in whose high school chemistry and physics were not taught. Fortunately we received rigorous grounding in mathematics, and from it I learned the importance of clear thinking, which is of paramount importance for a career in the sciences.

"My work has taken me to countries as distant as Russia, and South Africa, Spain and Japan, Sri Lanka, and Sweden– at the expense of the host country at that."

I have been deeply troubled by the almost total absence of black students pursuing scientific careers. I am continually being asked to help identify "deserving" blacks for positions in chemistry, in academia or industry.* I know that someone out there is a potential "deserving" candidate who is dreaming of being the next Billy Sims or Dr. "J" while ignoring his mathematics. He might not be the next Bert Fraser-Reid, either, but there are many more jobs for chemists than for football players, and furthermore, at thirty-five years of age, chemists are not over the hill.

* Present estimates place the total number of black graduate students in chemistry in the U.S. at 140!

Birthplace
Christiana, Jamaica

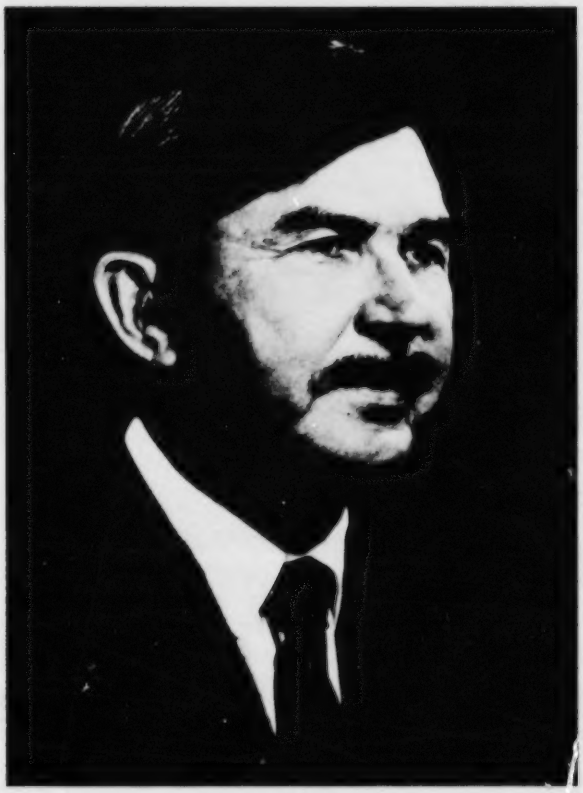
Education
B.S., Queen's University, Kingston, 1959, Chemistry
M.S., Queen's University, Kingston, 1961, Chemistry
Ph.D., University of Alberta, 1964, Chemistry

Present Position
Professor of Chemistry, Duke University

Honors
Chairperson, Division of Carbohydrate Chemistry, American Chemical Society (1983-1984)
Merck, Sharp and Dohme Award for distinguished contribution in organic chemistry (1977)
NRC Overseas Postdoctoral Fellowship (1965)
National Research Council Scholarship of Canada (1962)

Henry Taube

Inorganic Chemistry



Birthplace
Neudorf, Saskatchewan, Canada; naturalized U.S. citizen

Education
B.S., University of Saskatchewan, 1935, Chemistry
M.S., University of Saskatchewan, 1937, Chemistry
Ph.D. University of California, Berkeley, 1940, Chemistry

Present Position
Professor of Chemistry, Stanford University

Honors
Member, National Academy of Sciences
Nobel Laureate in Chemistry (1983)
Robert A. Welch Foundation Award in Chemistry (1983)
Doctor of Science, University of Chicago (1983)
Bailar Medal, University of Illinois (1983)
National Academy of Sciences Award in Chemical Sciences (1983)
The Linus Pauling Award, Puget Sound Section, ACS (1983)
ACS Award in Inorganic Chemistry of the Monsanto Company (1981)
Degree of Ph.D. Honoris Causa of the Hebrew University of Jerusalem (1979)
National Medal of Science, Washington, D.C. (1977)
Honorary Doctorate (L.L.D.), University of Saskatchewan (1973)

My involvement with chemistry began while I attended Luther College, where I was an assistant to Mr. P. Liefeld in his course in high school chemistry. My work as assistant was less a matter of choice than of necessity, the appointment having been arranged to make it possible for me to pay the bills for my education. These, it must be remembered, were depression years. In 1933 I left Luther College to attend the University of Saskatchewan at Saskatoon, not with the intention of majoring in chemistry, but rather wanting to pursue a course in general studies, with emphasis on English. I signed up for chemistry for a quite trivial reason, but it was not a bad choice because I found the work rather easy. Still, I was not strongly motivated, and did very little more than was required of me. This statement does not apply to my research for the M.S. degree under the direction of Professor J. W. T. Spinks. I worked very hard, perhaps because there was no real measure of what an adequate performance might be. I did not become curious about a wide range of problems in chemistry until I started my work for the Ph.D. degree at the University of California. Many influences conspired to produce this change of attitude. A great deal of credit for this goes to Professor W. C. Bray, my mentor during my Ph.D. studies, but a great deal also for the department as a whole. An interest and curiosity about chemical observations and the desire to understand them pervaded the department. It was maintained by our participation in teaching the introductory course, by the seminar program — this was in a sense the chief instrument of graduate instruction in the department — and by discussion among the graduate students.

"I worked very hard, perhaps because there was no real measure of what an adequate performance might be."

Ann Swanson

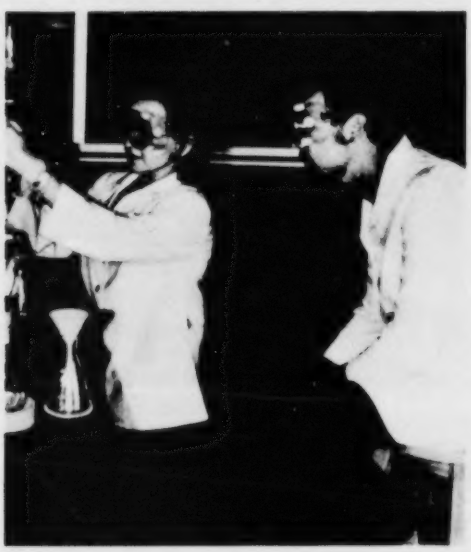
Biochemistry, Chemical Education, Chemical Carcinogenesis

First some personal information about me: I was born with a physical disability called osteogenesis imperfecta (commonly known as brittle bones) and throughout childhood I had numerous bone fractures. I was mainstreamed in public schools and was always expected to keep up with my schoolwork. Fortunately, my parents and teachers never allowed my disability to be used as an excuse for avoiding work. As a result of the many fractures, my legs remained weak and I did not grow to average height; today I am only 3 feet 8 inches tall. I stand on specially made platforms to elevate me to a height comfortable for doing laboratory work, giving lectures, or working in my kitchen at home.

How did I choose a career in science? For as long as I can remember, I have been fascinated with the sciences. My first love was astronomy, but as I grew older my interests tended more toward medical and life sciences, possibly as a result of my own medical experiences. In junior high school I had a terrific science teacher whose enthusiasm for her subject matched my own. She and my parents encouraged me to pursue my interests in science. In high school I took as much science and math as I could to prepare myself for college. In addition I participated in a summer chemistry program for high school students funded by the National Science Foundation and held at Northern Illinois University. That summer experience was invaluable because it gave me an idea of what would be expected of me later as a science major in college, and it also provided an opportunity for me to demonstrate — to myself and to professors — that yes, I can indeed handle college-level laboratory work. Experiences and opportunities like these are especially important for handicapped students. In college I majored in chemistry and minored in mathematics, in preparation for graduate work in biochemistry. Satisfaction for me in doing research lies in the discovery of some new knowledge about the world — learning something which no one else ever knew before. Satisfaction also lies in discovering some new information which might some day provide a piece of the puzzle to help us combat dreaded illnesses. In my current faculty position I teach college students General Chemistry, Organic Chemistry, and (my favorite) Biochemistry. I also am the Coordinator of our Medical Technology Program and serve as the college Pre-Medicine Advisor. I really enjoy sharing my knowledge and my enthusiasm with my students and helping them begin their careers!

For any young people considering careers in science, and *especially* for students who have handicaps, I offer the following advice. Get as good a background as possible in science and mathematics in high school and college. Be on the lookout (and ask your teachers) for information about out-of-school programs in science — at local museums, nearby colleges, or science centers — and participate in those programs. Be prepared to work hard, even in a certain class which may not be particularly interesting to you. But pursue a career in a field which really interests you, one which you *enjoy*. Few decisions are irreversible; all along the line you can change your mind and alter your career path. Students who have disabilities should get in contact with other handicapped scientists who can advise you and act as role models and mentors for you. I cannot overemphasize the importance of maintaining these networks of communication! Your first contact could be the Project on the Handicapped in Science, within the American Association for the Advancement of Science, Washington, D.C. There are over a thousand scientists with a wide range of disabilities working in the U.S. who are happy to be of assistance, and the project director, Dr. Martha Redden, can put you in touch with them.

"Get as good a background as possible in science and mathematics in high school and college."



Birthplace
Coal City, Illinois

Education
B.S., Northern Illinois University, 1970, Chemistry
Ph.D., University of Wisconsin, 1975, Biochemistry

Present Position
Associate Professor of Chemistry, Edgewood College, Madison, Wisconsin

Honors
Northern Illinois University Outstanding Chemistry Freshman Award
Northern Illinois University Outstanding Chemistry Senior Award
Procter and Gamble Research Fellowship Award
National Institutes of Health Predoctoral and Postdoctoral Traineeships

Ignacio Tinoco, Jr.

Biophysical Chemistry

I first became interested in chemistry because I liked to make explosions, colored fires, and bad smells. It was easier to buy chemicals then and I was very lucky not to blow myself up. My parents nearly did stop my experiments after I flooded the house while trying to install a water faucet for my lab in the basement. Floods in the laboratories still happen, but now they are caused by the graduate students actually doing the experiments. I usually just talk to the students about what experiments to do and what the results mean.

"I first became interested in chemistry because I liked to make explosions, colored fires, and bad smells."

Birthplace
El Paso, Texas

Education
B.S., University of New Mexico, 1951, Chemistry
Ph.D. University of Wisconsin, 1954, Chemistry

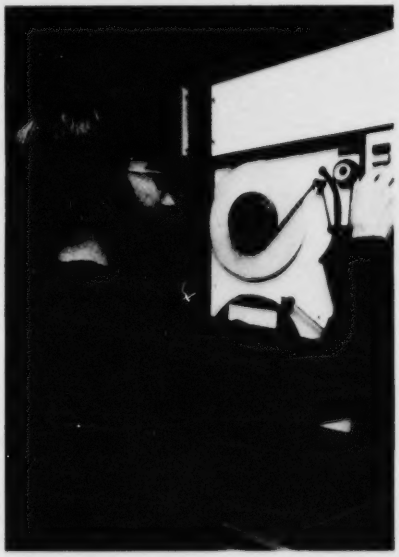
Present Position
Professor of Chemistry, University of California, Berkeley

Honors
D.Sc. (Hon.), University of New Mexico (1972)
Arthur D. Little Visiting Professor at MIT (1967)
California Section Award of ACS (1965)
Guggenheim Fellow (1964)
Miller Research Professor at University of California (1963)

Research scientists like, among other things, to solve problems. The everyday problems are little ones, such as how to fix the thermostat so that it keeps your bacteria growing at 37° centigrade instead of cooking them. Or, why won't the computer program run, although you can't find any errors in it. The long-range problems, you hope, are more significant.

The best thing about being a professor in science is that you get to pick the problems you want to try to solve. The graduate students who work with me are helping to find answers to such questions as: How do certain chemicals cause mutations? What properties of the chemical and the DNA favor mutation? How is a DNA molecule (which is a long polymer) folded up to fit into a virus, or to form a chromosome? The wonderful thing about chemistry and other sciences is that there will always be important questions to answer, yet people like you and me can always find useful answers to long-standing questions.

◀ Tonya Braceful, a freshman premed student at Michigan State University who wants to go on to the University of Chicago. She worked in a lab at Oakland University before coming to MSU. Her high school helped her a lot — she got a Westinghouse Award in her senior year which helped her get a scholarship and her lab jobs.



Chemistry graduate student loading a magnetic tape into a computer ▶

What is... ENGINEERING

Its mission — not to image or suppose, but to discover what nature does or may be made to do.
— Francis Bacon

Engineering is a profession in which a knowledge of the mathematical and natural sciences is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind.

While science "makes it known," engineering may be said to "put it to work – make it useful." Engineers are primarily occupied with the solution of real-life problems. They are "doers" – they must coordinate efficient and economical uses of materials, energy and human resources, always giving attention to the effects of such usage on the environment.

The student first strengthens his or her preparation by studying more mathematics (including calculus), chemistry, physics, computing, communication skills, humanities and the social sciences. Most of these studies can be completed in the first two years in either an engineering college or the transfer program of a community or liberal arts college.

The last two years prepare the student in a chosen area, such as agricultural, civil, chemical, electrical, industrial, or mechanical engineering. The courses put the student's knowledge of mathematics, engineering sciences, and computing to use. He or she learns how to approach a problem, to analyze all relevant factors, and then to synthesize the information in designing a solution. This preparation equips the student to attack future problems in a wide variety of situations.

John Slaughter

Applied Physics, Electrical Engineering, Science Administration

View of a modern petrochemical complex.

Young engineer surveying her world.

Photos courtesy of Chemical Industry for Minorities in Engineering, Inc.

Birthplace
Topeka, Kansas

Education
B.S., Kansas State University, 1956, Electrical Engineering
M.S., University of California, Los Angeles, 1961, Engineering
Ph.D., University of California, Davis, 1971, Engineering Physics

Present Position
Chancellor, University of Maryland

Honors
D.Sc. (Hon.), University of Notre Dame (1982)
Member, National Academy of Engineering (1982)
D.Sc. (Hon.), University of Maryland at College Park (1982)
D.Sc. (Hon.), Tuskegee Institute (1981)
D.Sc. (Hon.), University of Southern California (1981)
D. Eng. (Hon.), Rensselaer Polytechnic Institute (1981)
Distinguished Service Award, National Science Foundation (1979)

By age 14, I knew I wanted to be an engineer. My father built me a small radio repair shop, and I repaired radios in Topeka, Kansas for $2 plus parts. Despite the discouraging suggestions of counselors and teachers that I go to trade school, I held to my dream and eventually went to Kansas State University and earned a degree in electrical engineering. While studying for graduate degrees in engineering physics at UCLA and the University of California at San Diego, I spent 15 years at a Naval Research Laboratory working on computer process control. I overcame the biases built into the system and eventually was appointed Professor of Electrical Engineering and Director of the Applied Physics Laboratory at the University of Washington. President Jimmy Carter appointed me Director of the National Science Foundation in 1980, one of the most prestigious scientific administrative positions in the country. In 1982 I left NSF to become Chancellor of the University of Maryland at College Park. I have been an advocate of minority rights and affirmative action all of my life.

As a black engineer, I am often asked how I chose and advanced in my profession — what obstacles I encountered and, more important, what spurred me on. The answers are perhaps best summed up in the advice I give to students just getting started in science and engineering: Get your parents involved, take the right courses, and don't take "no" from a counselor. In addition, I urge talented young people not to stop with the bachelor's degree. The nation needs more of you to advance in research, in industry, and in academia and to qualify for teaching.

"Get your parents involved, take the right courses, and don't take 'no' from a counselor."

Robert V. Edwards Laser Applications in Chemical Engineering

From an early age I was an intense reader. Initially, my selections were unfocused, consisting mainly of adventure stories. A librarian directed my reading to science and science fiction. Every week she would sit and we would discuss the books I had just read. We talked as two people who enjoyed the same books, not as student and teacher. Along with my friends, I played with model airplanes and shortwave radio listening.

The school system was segregated at the time, but I had no shortage of knowledgeable, inspirational teachers. For example, one of my science teachers was an amateur radio operator and former fighter pilot. He introduced me to what turned into a lifetime hobby — amateur radio. There were other teachers of similar accomplishment. The advice they gave us sounds very strange today, namely, "Strive for excellence. You can be the best in the world at your chosen tasks, but the most technically demanding job you can get is that of high school teacher."

The white school system had an excellent technical high school (Baltimore Polytechnic Institute) that would now be called a "magnet" school. Fortunately, in my last year of junior high school, the Supreme Court outlawed segregated school systems and Baltimore made the best of a shameful situation by immediately desegregating its system. I attended the technical high school and went from there to the Johns Hopkins University as an electrical engineering major. I discovered that I wanted to look more deeply into things than I was allowed to do as an engineering major. Therefore, although I loved engineering, I switched my major to mathematics and received an A.B. degree in it.

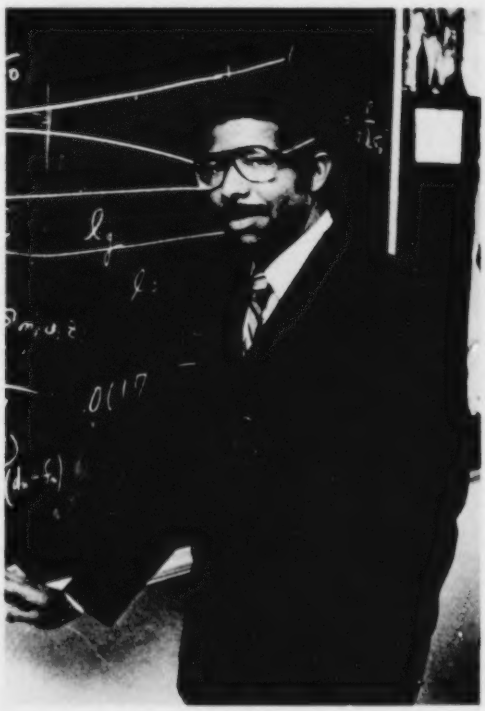
"When I realize that some student has learned from me or when a laboratory experiment works out, I am elated."

With my mathematics background, it was relatively easy to get into graduate school in chemical engineering at Johns Hopkins University. In due course, I graduated with a Ph.D. degree and came to Case Western Reserve University for two years of postdoctoral research. I joined the faculty of CWRU after my postdoctoral period, and have been here ever since. I hold the rank of Professor. What has it meant to me?

My career as a professor of engineering has been on occasions frustrating, tedious and maddening. On other occasions, it is a real joy. When I realize that some student has learned from me or when a laboratory experiment works out, I am elated.

Far from living in an ivory tower, I continually meet interesting people from other schools, industry and government. There are many opportunities to travel, even to other countries.

As with any undertaking, my career has its share of minuses, but the pluses and victories make it all worthwhile to me.



Birthplace
Baltimore, Maryland

Education
A.B., Johns Hopkins University, 1962, Chemical Engineering
M.S., Johns Hopkins University, 1964, Chemical Engineering
Ph.D., Johns Hopkins University, 1968, Chemical Engineering

Present Position
Professor of Engineering, Case Western Reserve University

Honors
Sigma Xi
Phi Lambda Upsilon

Women and Minorities In Space

by Perry Clark

INTRODUCTION

Now that our planet has been completely explored, people are turning their attention skyward. Humans have always wanted to explore, to know what lies beyond the horizon. Space beckons as a new frontier, full of new worlds, new questions, and new answers. On the following pages, three explorers of this new frontier talk about science, space, and what prospective scientists can do to become a part of humanity's quest to understand not only our world, but the entire universe.

Sally Ride

Curiosity may have killed the cat, but according to *Dr. Sally Ride*, it is an essential ingredient for the aspiring scientist. Ride, who made her mark as America's first woman astronaut during a six-day flight aboard the space shuttle orbiter Challenger in June, 1983, compares scientific research and solving scientific problems to solving puzzles, and says curiosity is a key to figuring out those puzzles. "If you have got the curiosity, you'll have the incentive to follow the problem through," she says. "Of course, you need tenacity and you need background to attack the problem, but the most important thing is curiosity."

Ride joined the National Aeronautics and Space Administration (NASA) in 1978 after receiving her Ph.D. in physics from Stanford University. Her interest in science developed early in junior high school and extended right through her collegiate days. "I always preferred math and science classes to English and history classes," she recalls. "I'm the kind of person who always enjoyed working on puzzles and working on games. That's what research science is. You pick a puzzle and then try to solve it. That was certainly the aspect of research science that I enjoyed."

High school courses in computer science and mathematics were especially valuable in Ride's pursuit of a scientific career. She found mathematics useful because it is important to all fields of science, while her current work at NASA is heavily involved with computers. She urges prospective scientists to make friends with computers. "One of the most important things kids can work on right now is making sure they are familiar with computers, not necessarily with programming, but with developing their computer skills," she says. "That's something very important in whatever job they go into."

Ride sees a flaw in the U.S. educational system, which she believes has introduced computers into schools without preparing teachers to demonstrate computer capabilities to students. "I think there are a lot of places where the kids know more than the teachers," she says, adding that teachers also fail to encourage students, particularly girls, to work with computers. "Girls as well as boys need to be encouraged. It's part of some parents and some teachers that they either subtly or not so subtly encourage the boys to work on computers, but they do not give that much encouragement to the girls."

Such subtle or not-so-subtle discrimination was fortunately not a problem for Ride, who says she considers herself "lucky" in that regard. She attended an all-girls high school in Los Angeles, California, where she was instrumental in starting classes in science

Astronaut Sally K. Ride uses a screw driver to clean out an air filtering system in the mid deck of the Space Shuttle Challenger.

PHOTOGRAPH COURTESY OF NASA

and calculus. At Stanford, she was one of several women majoring in physics, and joined NASA after the space agency had committed itself to bringing female astronauts into the program. "By the time I got there (NASA), they had adjusted to the idea, if there was any adjustment to be done," she says. She described the attitude at both Stanford and NASA as "enlightened."

Ride will soon venture spaceward again, this time on a 10-day flight aboard the shuttle orbiter Columbia with astronauts Robert Crippen, John McBride, Kathy Sullivan, and Dave Leestma. The crew will operate a radar for geologic studies, and will also launch the Earth Radiation Budget Satellite. The Satellite will monitor radiation coming into and radiated away from the earth in an effort to measure the greenhouse effect, a gradual warming of the earth's atmosphere resulting from increased levels of carbon dioxide generated by the burning of fossil fuels. The flight will also feature a space walk by Leestma and Sullivan. Sullivan will be the first woman spacewalker in history.

Being in space is a "euphoric" experience, according to Ride. She finds that training can simulate virtually every aspect of space flight but one — weightlessness, which she describes as "just plain fun." Training involves close collaboration between the astronauts and scientists whose experiments will fly aboard the shuttle. The astronauts also spend up to 20 hours a week in shuttle simulators, practicing all aspects of the mission.

Ride anticipates a bright future for space exploration, including a more active human presence in space, particularly if NASA receives funding for a space station. "I think that it's inevitable that within the next 10 or 15 years, people are going to be living in space," she predicts. "I think we're going to have industries out there, I think we're going to have, maybe not colonies, . . . but we're certainly going to have people living out there for several months at a time."

Sally Ride hope to be one of those people.

PHOTOGRAPH COURTESY OF NASA

Onboard scene, Space Shuttle Challenger. Left to right on the flight deck are Norman E. Thagard, Robert L. Crippen, Frederick H. Hauck, Sally K. Ride, and John M. Fabian.

PHOTOGRAPH COURTESY OF NASA

Guion Bluford, Jr. ▲

Lt. Col. Guion Bluford, Jr., is a man who loves his work. An aerospace engineer and Air Force pilot, Bluford is America's first black astronaut. His lifelong interest in aviation, science and space, along with a desire to tackle and solve problems, led Bluford to join the NASA astronaut corp. "I've been interested in science ever since I was a kid," he says. "I developed a strong interest in science and math as far back as elementary school. I liked to read books on airplanes and rocket engines. I also enjoyed doing crossword puzzles, cryptograms, and mind pieces — they really fascinated me."

Bluford has pursued his interest in science and aviation without letup. After graduating from high school in Philadelphia, Pennsylvania, in 1960, he attended Pennsylvania State University, receiving his B.S. in aerospace engineering in 1964. A distinguished ROTC cadet, he acquired his pilot wings in 1965 and began seven years of Air

PHOTOGRAPH COURTESY OF NASA

PHOTOGRAPH COURTESY OF NASA

Sally K. Ride, STS-7 mission specialist, was captured at her sleep station in the Challenger's mid deck. Some astronauts choose to sleep in various positions with either their feet or upper bodies or both anchored and others elect to use the sleep restraint device used by Dr. Ride.

Force service as a combat pilot, instructional pilot, and assistant flight commander. He entefed the Air Force Institute of Technology residency school at Wright Patterson Air Force Base, Ohio, in 1972.

In 1978, the same vear he joined NASA, Bluford received his Ph.D. in aerospace engineering. His interest is computational fluid dynamics, which involves predicting how airplanes will fly. Such predictions can be made by building a model of an airplane and placing it in a wind tunnel, or by the use of computer models. Bluford specializes in developing computer models.

Computers were also important to Blutord during his flight aboard the space shuttle orbiter Challenger late last summer, a flight that included the first night launch and landing in the shuttle program. The crew, aided by computers, deployed a satellite for the government of India and operated the Challenger's remote manipulator arm. They also conducted measurements to help scientists understand the biological effects of space flight on humans, and activated various earth resources and space science experiments. While Bluford found the entire flight pleasant, he noted two aspects that were especially impressive — weightlessness and the view. "Zero gravity is very similar to floating in a swimming pool without being able to feel the water," he says, adding that, "The view out the window was spectacular. It gives you a broader perspective of the earth."

Bluford also has a broad perspective on discrimination. He did not encounter it in his career pursuits, but says he did experience difficulty at other times. "I think any black American who is my age (41) has faced some form of discrimination," he says. "I've seen some of it myself with respect to housing." Bluford believes safeguards are now in place to help counteract the problem. "A show of discrimination would be illegal in many aspects," he notes. "For young people who still face it, there are a lot of complaint avenues available."

Careers in scientific fields are also available, he says. "There are many opportunities, particularly for minorities. Because our country is very technologically oriented, future industries will be based on technologies that are being developed today. I encourage kids to get in these fields because of the job opportunities." Bluford sees a permanently occupied space station, which NASA hopes to have in operation by the 1990s, as opening even more doors. "I envision a lot more flying in the space shuttle, and a lot of opportunities. There will be a lot more activity associated with the space program," he predicts, including new high technology industries that will provide many jobs for scientists and engineers.

Before plunging into a scientific career, Bluford suggests that prospective scientists make certain they are really interested in the field they plan to enter. "I'm very interested in aviation and I'm very interested in what I'm doing," he says. "I enjoy creating something and solving problems. The most important thing is to make sure you are interested in your career. If you are interested in science, get as much education, particularly science and math, as possible. In high school, I knew I wanted to be an aerospace engineer, so I focused on those courses." Bluford adds that an open mind, curiosity, and hard work are also important. "There's an awful lot that makes a good scientist," he says.

The five-member astronaut crew aboard the Space Shuttle Challenger displays one of the special cacheted postal covers which flew on STS-8. Richard H. Truly, crew commander, holds the cachet; other crew members are, left to right, Daniel C. Brandenstein, William E. Thornton, Guion S. Bluford, and Dale A. Gardner. PHOTOGRAPH COURTESY OF NASA

Women and Minorities In Space

Franklin Chang-Diaz ▼

Even when he was a seven-year-old boy in Venezuela, *Dr. Franklin Chang-Diaz* wanted to be an astronaut. In those days, his space ships consisted of big boxes filled with old radios, televisions, and any other electronic gear he and his friends could find. Now, as an astronaut with NASA, his space ship is the space shuttle, and his electronics are some of the most sophisticated in the world.

"All my friends wanted to be astronauts," Chang-Diaz recalls. "Five or six of us used to play space ships. As the years passed, all these children went their separate ways. I was left there, but the idea of being an astronaut stuck with me." That idea steered Chang-Diaz toward science. He concluded in high school that future astronauts would also be scientists. "That was very much in line with what I wanted to do," he says. "I wanted to be involved in scientific research."

After moving to Costa Rica and graduating from high school there, Chang-Diaz worked and saved money so he could travel to the United States. With the help of his parents, he reached Connecticut in 1968 and enrolled at Hartford High School. One year later he received a scholarship and entered the University of Connecticut, where he studied mechanical engineering and physics. After receiving his B.S. in mechanical engineering in 1973, he went to the Massachusetts Institute of Technology (MIT) to pursue a Ph.D. in physics.

Becoming an astronaut was still Chang-Diaz's goal. At MIT he studied nuclear fusion, the process by which the sun and stars produce energy. He says he chose that branch of physics because, "I figured someday space ships would use that [fusion]." He twice applied to NASA for an astronaut position after receiving his Ph.D. in 1977. He was turned down the first time because, he speculates, he was not a U.S. citizen. Once he became a citizen, however, he was readily accepted. "I never really felt any discrimination by the space program or NASA in the selection process," he says, noting that all NASA astronauts are U.S. citizens.

Chang-Diaz is someone who obviously lives his philosophy of pursuing a goal, not just planning for it. "A person must establish a sense of movement," he says. "Some people spend all their time planning what they are going to do in the future and never do it. You need to get going in some rough direction. Don't spend all your life planning. Once you get moving, then all kinds of programs open up as you go along."

At NASA, Chang-Diaz helps design rocket engines that will eventually power people to Mars and the moons of Jupiter and Saturn. He hopes to make his first shuttle flight next year and eventually be part of a planetary mission. "I have a strong sense of adventure," he says, adding, "To me, scientific research is very much an adventure. It's being somewhere no one else has been, intellectually speaking. It's doing things better and more efficiently."

Chang-Diaz dismisses those who contend that money spent for space exploration would be better spent on earth. "The amount of money is all relative," he argues. "Less than one cent of each tax dollar goes for space. That fraction of a cent goes a long way toward providing people with better medicines, better materials such as electronics, or satellite communication. We're not going *into* space, because we're already there. Space really is our home in terms of our present environment. It behooves us to explore our backyard."

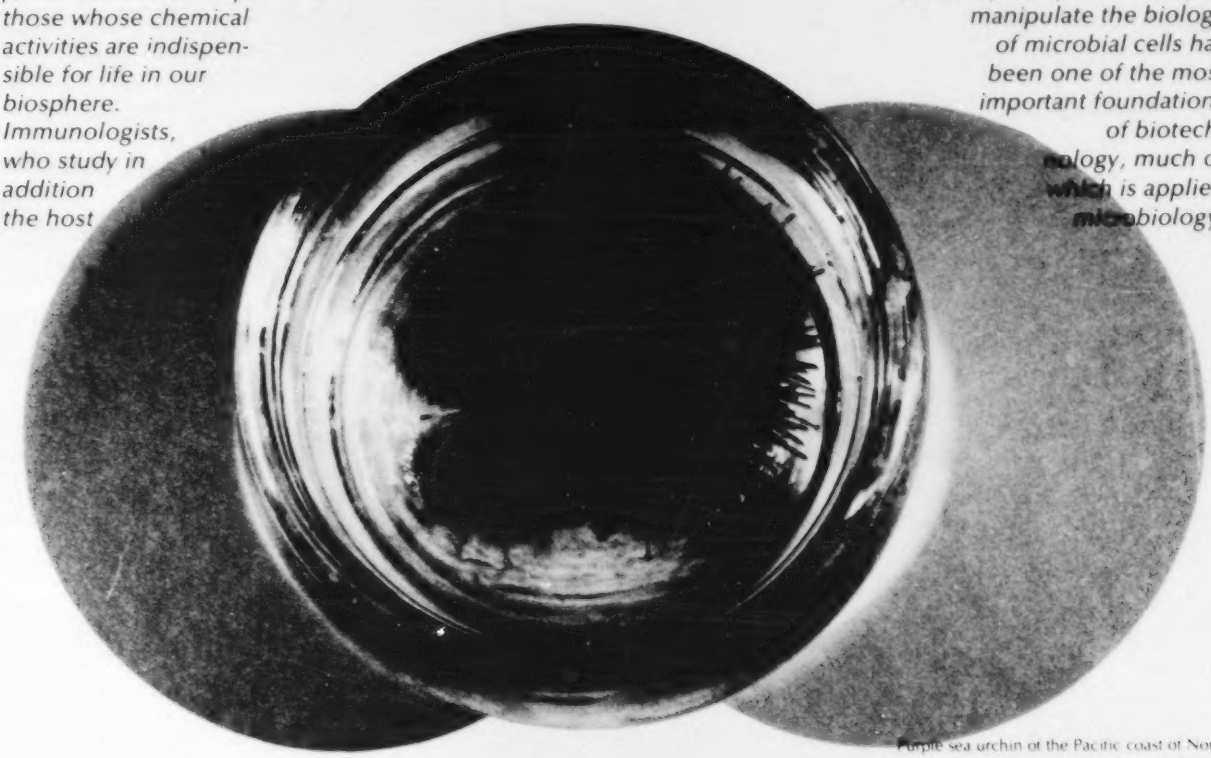
Space stations and space factories filled with people producing materials for use on the ground is what Chang-Diaz envisions for the future. The price of launching satellites will fall, and he predicts that many countries will use them to accelerate their development, not only in communication, but also in agriculture and natural resources. The long-term future will include the exploration of the solar system. "It's going to be really exciting," he says.

Perry Clark is a science writer and photographer based in Okemos, Michigan.

Franklin R. Chang-Diaz with shuttle model.

What is... MICROBIOLOGY

Modern microbiology is an extremely broad, multidisciplinary field. It arose from two separate branches of biology; the observation of microscopic life and the study of infectious disease. When the role of microbes in human and animal disease became apparent, the two branches merged. Today microbiologists study all sorts of organisms – from those which parasitize animals or plants to those whose chemical activities are indispensible for life in our biosphere. Immunologists, who study in addition the host responses to parasitism, are usually included among microbiologists. Thus, the organisms whose study comprises the field of microbiology range from viruses with sufficient genetic material for only two or three genes to tapeworms, which can grow to several feet in length. The processes which microbiologists investigate range from gene expression at the molecular level and the biochemistry of cell surfaces to the composition of cell populations in the spleen and the role of various organisms in the biodegradation of chemicals in the soil. Microbiologists use the techniques of genetics, chemistry, biochemistry, physiology, ecology, and pathology. They are united by their interest in the biology of the cells they study. The ability to manipulate the biology of microbial cells has been one of the most important foundations of biotechnology, much of which is applied microbiology.



Purple sea urchin of the Pacific coast of North America.

Ramon Piñon, Jr.

Regulation of Cell Growth

Birthplace
El Paso, Texas

Education
B.S., Texas Western College, 1960, Physics
Ph.D., Brown University, 1973, Physics

Present Position
Associate Professor of Biology, University of California, San Diego

Honors
Research Career Development Award (1971-1977)
Gulf Oil Fellowship (1962)
Woodrow Wilson Fellowship (1961)
Highest Honors, Texas Western College (1960)

Luck and serendipity have played a large part in determining where I am today. I was born and raised in El Paso, Texas, when it was still a small, and out-of-the-way, border town. Up to the age of thirteen I lived completely within the confines of the Mexican barrio, and until my father decided to build a house outside the city (only eight miles from our old home) I had not had any contact with English-speaking children my age. I was always interested in how things work, and began to develop a serious interest in science in high school. This trait I inherited from my parents, both of whom, although lacking a formal education, were quite interested in the world around them. My father and uncles were all industrious men, jacks-of-all-trades, involved in construction, auto, home appliance and radio repair. My father was a tinkerer and as a child I marveled at his ability to build and repair machines.

"I was always interested in how things work."

With their support I decided to study physics when I went to college. I became interested in nuclear physics, because it seemed to me that this was the way to understand the nature of the universe. I was very ambitious in those days. With the help and encouragement of my physics teachers I went to graduate school at Brown University. This was an exciting time in nuclear physics, and I did my degree in the emerging field of elementary particle physics. After I obtained my Ph.D., I was given an opportunity to continue my studies as a postdoctoral fellow at the University of Nijmegen, in the Netherlands. It was there, after meeting a geneticist, that I became interested in genetics and molecular biology. It seemed to me that these two sciences offered the way to really understand the nature of living organisms. Hence, again with government support and the hospitality of the Department of Genetics at the University of Washington, Seattle, I started learning genetics. Fourteen years later I am teaching in a Department of Biology, and involved in doing research in cell division and cell differentiation, practicing without a license, so to speak, since I do not have a degree in any of these areas.

Gerald V. Stokes

Microbiology, Bacteriology

Birthplace
Argo, Illinois

Education
A.A., Wilson Jr. College, 1965, Chemistry
B.A., Southern Illinois University, 1967, Microbiology
Ph.D., University of Chicago, 1973, Microbiology

Present Position
Associate Professor of Microbiology, The George Washington University Medical Center

Honors
U.S. Public Health Predoctoral Trainee
American Cancer Society Postdoctoral Fellow
NIH Postdoctoral Fellow
National Science Foundation Grantee

Students occasionally ask "What got you interested in science?" What they actually want to know is what motivated a black person to choose science (microbiology) as a career. The answer to the question is by no means simple or direct. A career, whether it be in science, business or art, usually begins with the satisfaction that is gained from the effort. Fun? No! Rewarding? Yes! An education is like a long-term investment in one's self. The time and effort put into a college education is the initial preparation for the design of a product which will be with *you* for the rest of your life. It's for that reason that you should question the advice offered by anyone and compare it with several others before making a final decision. Pay particular interest to the career experiences of minority scientists and look for common denominators.

Here is a very small part of my story. I grew up in a small town outside of Chicago (Argo, Illinois). Elementary schooling consisted of the public (semi-segregated) school system until high school where the "mix" occurred. Science classes, until that time, were like any other; long and tedious — until biology. It was in high school that I had a biology teacher who impressed me with his adventure in teaching and friendly, relaxed humor. Prior to the taking of that class in biology I had mainly taken the general studies classes (not college prep). I realized that one need not excel in everything in order to be good "college material." Had I followed the advice of my high school advisors, I would have relegated myself to the technical (shop) courses, which were expected of black students and usually ended many promising careers in higher education. College, to many, was a place where true talents were expressed rather than developed. I believe the latter to be true.

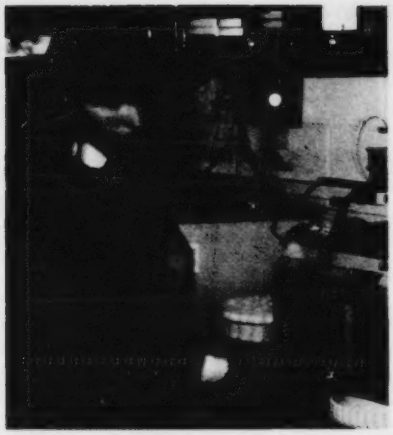
"My first love was chemistry. I found it exciting, but not alive."

A black student of even average high school performance has the potential to succeed in college and a career in the sciences. One has to simply develop the maturity to adjust to adversity and graciously accept success. My first love was chemistry. I found it exciting, but not "alive." Microbiology was alive and therefore became my area of concentration. It's obvious that my youthful perceptions of chemistry versus microbiology were incorrect. They are both alive and the same. Experience will reveal that biology, chemistry and mathematics are all the same. They are dynamic and alive. Initially I found myself "the only one" in my career area and to some degree that prevails today, but today there are far more opportunities to meet and interact with other black (minority) scientists professionally and socially.

Through one's professional organizations (such as the American Society for Microbiology, of which I am a long-standing member) there are opportunities to meet other minority scientists who have made science career choices similar to yours. We come from different backgrounds, states, schools and family structures. Some were honor (scholarship) students; most were not. We all share in the inner enjoyment of our efforts and desire to make small meaningful contributions which collectively have major impacts such as making your choices less uncertain than ours.

Keith R. Yamamoto

Molecular Mechanisms of Gene Expression



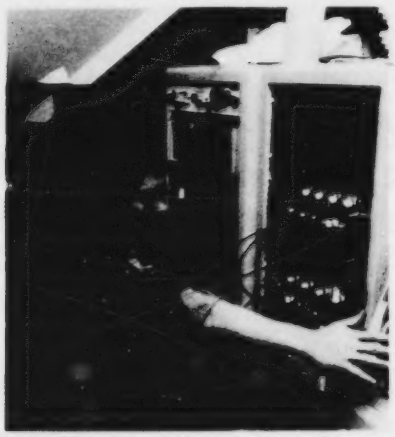
ABOVE
Graduate student in physiology using high pressure liquid chromotography which can separate out compounds and measure nucleotides like ATP and ADP.

Birthplace
Des Moines, Iowa

Education
B.S., Iowa State University, 1968, Biochemistry & Biophysics
Ph.D., Princeton University, 1973, Biochemical Sciences

Present Position
Professor of Biochemistry, University of California, San Francisco

BELOW
Graduate student in physiology with electrophysiology device that studies nerve activity.

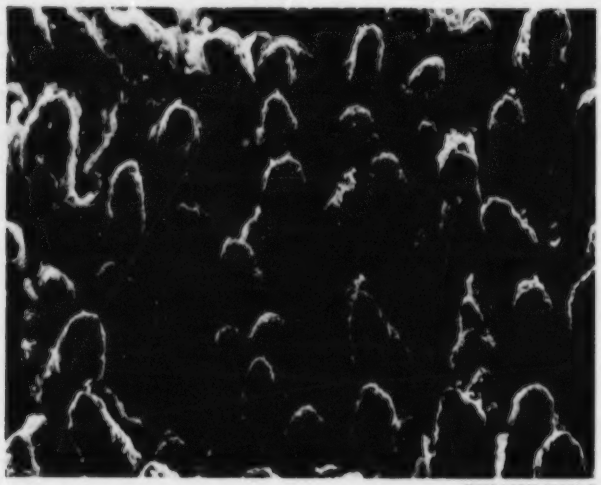


My research, carried out in collaboration with about ten graduate students and postdoctoral colleagues, is focused on defining the molecular mechanisms that regulate the expression of a particular set of genes in mammalian cells. In my view, the endeavor of basic research has some interesting parallels with the development of a work of art. Both demand intense personal commitment within a relatively open organizational and intellectual framework. Just as an artist decides upon a subject, medium and style, a scientist chooses a research problem and method of investigation, and derives from the results a personal version of "truth" to be presented to peers for their evaluation, and for their use in evolving new concepts. Conducting a research program within a university adds other interesting dimensions: a challenging teaching mission and a joint learning experience with a dynamic pool of students and colleagues. In contrast to a common stereotype, basic research is a highly social process; its success builds and indeed depends upon the development of close and lasting interactions that are not only scientific, but also personal. Thus, science is also fun and personally rewarding. These are essential components in the hard work, the intellectual stimulation, the excitement of driving toward an interesting answer, and the satisfaction of understanding fundamental life processes.

"Basic research is a highly social process."

What is... PATHOLOGY

NORMAL TISSUE



DISEASED TISSUE

The word pathology is derived from two Greek words, pathos meaning morbidity or disease and logos meaning the science of. . . . We define pathology today as the science of the concepts and principles of disease. It must deal with the disease-causing agents, their interactions with the host and the consequences of these interactions as they are reflected in morphologic and functional deviations from the state of health. Pathology forms a vital bridge between basic and clinical sciences of medicine.

As a basic scientist, the pathologist is involved in research on fundamental mechanisms of disease processes. As a clinician, the pathologist contributes substantially to the diagnosis of a disease. Tissue samples such as skin and organ biopsies, blood, urine, sputum, etc. are submitted to the pathologist who examines these samples and renders a diagnosis to the clinician. The diagnosis is essential for the clinician to decide upon the treatment. Surgeons may interrupt surgery waiting for an immediate diagnosis by the pathologist before they complete surgery in a questionable case such as in suspected cancer.

The pathologist is also responsible for performing an autopsy when patients die. This is particularly important in case a correct diagnosis could not be rendered while the patient was alive or in a case of an unexplained sudden death with possible criminal implications (forensic pathology). You may have watched the TV program "Quincy" in which a forensic pathologist is portrayed.

The pathologist as a scientist is a vital contributor to biomedical research and as a diagnostician, he/she is essential to the total care of a patient. An example of this dual role is illustrated by the accompanying photographs which show the normal surface of the intestine and the change that occurs with a virus disease that affects the intestinal tract. Histopathologic studies revealed that part of the disease problem was a marked shortening of the finger-like projections (villi) which in turn leads to severe diarrhea. By understanding this mechanism, appropriate patient care can be administered to correct the problem.

Eugene W. Adams

Comparative Pathology, Tumor Pathology, Electron Microscopy

Birthplace
Guthrie, Oklahoma

Education
D.V.M., Kansas State University, 1944, Veterinary Medicine
M.S., Cornell University, 1957, Comparative Pathology
Ph.D., Cornell University, 1961, Comparative Pathology

Present Position
Assistant Provost and Director of International Programs, Tuskegee Institute

Honors
NIH National Resources Research Council (1973-1976)
Norden Award for Distinguished Teaching in Vet Medicine (1964)

As a young boy my interest in wanting to become a veterinarian was very simple — I liked animals and I knew that veterinarians helped animals. Moreover, I was fortunate that in my home town there was a highly successful black veterinary doctor. This was an advantage most minority children do not have; thus few are exposed to this exciting profession, or visualize themselves as veterinarians.

However, after many years of working in the profession as a recruiter/counselor for veterinary students in addition to being active in teaching and research in the specialty of pathology, I am convinced that love for animals and even working with a veterinarian are important, but to effectively compete for the limited spaces available in the veterinary schools, one must begin early to lay down the proper foundation. This means that during the high school and pre-veterinary school years, courses in biology, chemistry, physics and mathematics should make up a substantial part of one's course of study.

The reasons are great for entering veterinary medicine. Very few fields offer anything like the variety of opportunities for a young man or woman to be both useful and creative. While veterinary medicine is concerned with disease and health of animals, it plays an important role in human health because we live so close to animals, and depend on some for food. A veterinarian is by profession, perhaps, the greatest humanitarian that one can think of — a very special kind of doctor. We are concerned with animal life and its effect on human life at the same time.

"A veterinarian is by profession, perhaps, the greatest humanitarian that one can think of."

Although most veterinarians have private hospitals to treat sick pets and food animals, there are many job opportunities in other areas. These include working for national, state and city agencies that provide public health services, the United States Army, the Food and Drug Administration and foreign service assignments. Many commercial firms use animals and hence need veterinary skills in producing and testing medicines sold in drug stores. We encourage you to prepare yourself to enter a profession that has made and will continue to make significant contributions to animal and human medicine in this country and throughout the world.

Tracie Bunton

Electron Microscopy

Birthplace
Ypsilanti, Michigan

Education
B.S., Michigan State University, 1976, Veterinary Medicine
D.V.M., Michigan State University, 1977, Veterinary Medicine
Ph.D., University of California, Davis, 1982, Comparative Pathology

Present Position
Assistant Professor, Department of Pathology, Michigan State University

I became interested in veterinary medicine during high school, for reasons that are unclear since I had no exposure to it and no role model. During veterinary school I became interested in pathology, but was not prepared to jump right into another academic program after graduation. I, therefore, practiced for one year in a small animal practice, which confirmed my suspicions that I did not want to be a practitioner for the rest of my life. A friend of mine and I used to joke during veterinary school about finding our "niche" in life, and in pathology I've found mine. For me, it's almost a hobby rather than work, and is the most versatile, interesting, and challenging field in veterinary medicine. My advice to all students interested in veterinary medicine is to make sure that it's something that you truly want, because it won't be easy. My advice to minority students is to be prepared for all of your successes and failures to be attributed to the fact that you are a minority, and not to hard work or lack thereof. This will be the single most frustrating aspect of your career.

"For me, it's almost a hobby rather than work."

Cont. from pg. 15

PROFESSIONAL ORGANIZATIONS

1. **Associations of/for Racial and Ethnic Minority Science, Engineering and Health Professionals (1983), MESHwork Project**, Paula Q. Hall, Patricia A. Boulware and Alicia Leach, eds., American Association for the Advancement of Science, 1776 Massachusetts Avenue NW, Washington, DC 22032.
   — This is a compendium of names, addresses and purposes of 29 professional organizations representing different areas of science and technology.

2. **NSTA Handbook**, The National Science Teachers Association (1983-1984), 1742 Connecticut Avenue, NW, Washington, DC 20009 ($5.00).
   — This handbook contains information about the NSTA and also about other interest groups, state and local science teachers publications, committees, panels, etc.

Microbiologists examining an auto radiogram, an x-ray film of pieces of chromosomes to see where a virus has integrated into rat chromosomes.

HOW TO CONTACT COLLEGES AND UNIVERSITIES

Your school library or local library will have the books listed below, which contain the addresses of American colleges and universities, information about enrollment, fields of study, prerequisite requirements, financial aid, etc. Once you have chosen some institutions that are of interest to you, write to the Admissions Office for more detailed information about their academic programs.

1. College Blue Book, narrative description volume.
2. Peterson's Annual Guide to Undergraduate Study. end

What is... PHARMACOLOGY

The word pharmacology *comes from the Greek* pharmakon, *equivalent to drug, medicine or poison, and* logia, *meaning study. It is a branch of biology, since it is concerned with living organisms, and it borrows heavily from kindred subjects like physiology and biochemistry for much of its substance and experimental techniques. Pharmacology is also related equally to chemistry, since it deals with chemical agents and depends upon knowledge of their sources and properties. Pharmacology is also an essential part of medicine. Although a drug, in broad terms, is any chemical agent other than food that affects living organisms, in its medicinal sense, a drug is any chemical agent used in the treatment, cure, prevention or diagnosis of disease.*

Thus, it may be said that pharmacology is the unified study of the properties of chemicals and living organisms and all aspects of their interactions. Pharmacologists study the actions and effects of chemicals at all levels of organization of living material and of the handling of chemicals by the organism. In a narrow sense, pharmacology is the science and study of how chemicals produce their biologic effects.

Pharmacologists are employed by universities (in colleges of medicine, veterinary medicine, osteopathic medicine and pharmacy), by drug companies and by research institutes, such as the National Institutes of Health.

Stock refrigerator of media and solutions for immunology research.

Yvonne Clement-Courmier

Pharmacology, Mechanism of Biogenic Amines

Birthplace
Abbeville, Louisiana

Education
B.S., Southern Methodist University, 1970, Biology
Ph.D., Brown University, 1974, Physiological Chemistry

Present Position
Assistant Professor, Departments of Pharmacology and Neurobiology and Anatomy, The University of Texas Medical School

Honors
Alpha Lambda Delta
Beta Beta Beta
Iota Sigma Pi
Pharmaceutical Manufacturers Association Foundation Faculty Development Award (1978-1980)
Ford Foundation Fellow (1970-1974)
Dedman Fellow (1966-1970)

For as long as I can remember I have liked science. When I was growing up, I collected butterflies, snakes, frogs and lots of bugs for fun. Luckily my parents encouraged my scientific curiosity and accommodated all of my collectibles. My most memorable experiences as a teenager were participating in numerous laboratory experiments after school. My high school biology teacher encouraged me to learn science by doing. She made it possible for me to set up some classical physiology experiments after school. One of my most successful experiments was monitoring the effects of atropine on the heart of a frog. Overall, my school and home environment was very supportive of my scientific curiosity. More importantly, my high school experiences solidified my interest in research by showing me how much *fun* it can be.

"My high school experiences solidified my interest in research by showing me how much fun it can be."

Success in life I was taught, and still believe, comes from hard work and providing service to others. Thus, I saw a career in medical research as an opportunity to satisfy my personal interest in science while at the same time helping to improve the quality of health care for others. I was fortunate to have had the opportunity to study biochemistry at Brown University and pharmacology at Yale University. I studied the mechanism by which drugs used to treat mental disorders, such as schizophrenia, produce their side effects. I have continued this work for the last eight years in the Department of Pharmacology, University of Texas Medical School. I believe that this work is important because it affords the possibility to not only better understand how drugs work but it also makes it possible to design better drugs with fewer side effects.

One area of pharmacology that particularly interests me is the application of basic pharmacology to clinical research. Pharmacology is truly a discipline where broad areas of research can be applied to clinical problems. It also allows the investigator many opportunities to study a variety of problems throughout his/her career. I believe that medical research is a rewarding and fulfilling way to spend one's life and can recommend it to students interested in careers in science and medicine.

Janice Stickney

Cardiac Pharmacology

Birthplace
Tallahassee, Florida

Education
A.B., Oberlin College, 1962, Zoology
Ph.D., University of Michigan, 1967, Pharmacology

Present Position
Associate Director of Scientific Affairs, G.D. Searle Company

Honors
National Merit Semifinalist
Tuition Scholarship, Oberlin College
Sigma Xi

I became interested in science while in junior high school. I was fortunate to have had teachers and parents who encouraged my interest in science. The interest continued in college where I majored in zoology. The interaction between drugs and physiological processes was introduced to me in several college courses. The subject intrigued me. Pharmacology was a logical area in which to pursue graduate studies.

I think that one of the most exciting aspects of a career in science is the fact that there is always something new and exciting to learn. Many skills are required for the thorough planning and execution of projects. Acquisition and practice of these skills can be very stimulating. Interactions with peers offer opportunities for exchange of ideas and information. These exchanges can be fun as well as challenging and interesting.

There are several different types of career opportunities for individuals with a Ph.D. in pharmacology. Positions are to be found in academia, industry (pharmaceutical, but others as well such as chemical, cosmetic, and foods), federal and state governments, and private research institutes. Activities run the gamut from hands-on bench research to chairing university departments to making policy decisions in upper management.

The excitement and opportunities to which I am exposed as a pharmacologist can be found in most other areas of science. There could not be a better time than now for a minority student to pursue a career in science.

"There is always something new and exciting to learn."

Paul H. Sato

Drug Metabolism

I am one of about 20 faculty members of the Department of Pharmacology and Toxicology at Michigan State University. Our chief responsibility is to teach in the medical schools of the University. Teaching medical students is a challenge because the students need to know more than we have time to teach them. We try to inspire the students to learn more than they are taught. Consequently, although each faculty member gives only 20-30 lectures per year a great deal of effort is spent in preparation.

"It is a simple and unending occupation because each solution poses many new questions."

In addition, about half of our time is spent doing research. Research is very interesting and enjoyable; it is probably more of a hobby than a job. Although the results of research may be of enormous benefit toward the prevention or treatment of a disease, realistically, the reward more often is self-satisfaction. Most of the research in a university is investigator initiated. The researcher poses the question and proposes how he or she will answer it. It is a simple and unending occupation because each solution poses many new questions.

I became a pharmacologist because my father, though not in this discipline, was a scientist. As a result I became aware of what scientists do. Training in the sciences is not difficult, but is quite long. I attended Jamestown College, New York University and received postdoctoral training at Roche Institute of Molecular Biology, a total of 10 years after high school. During this time I learned basic biology, but more importantly, how scientists learned these facts, and what types of problems can and cannot be solved.

Birthplace
Mt. Vernon, New York

Education
B.S., Jamestown College, 1971, Chemistry
Ph.D., New York University, 1975, Pharmacology

Present Position
Associate Professor of Pharmacology & Toxicology, Michigan State University

Honors
Postdoctoral Fellowship, Roche Institute of Molecular Biology (1975-1977)

A laboratory research technician weighing a guinea pig being used in research on Vitamin C deficiency.

A research assistant looking at a solution of luria broth, a media used for growing *E. coli* in recombinant DNA research with plasmids.

Stuart Taylor Cellular and Molecular Basis of Drug Function

Biological research was a natural outgrowth of my background. My father was a physician. I grew up in a medical environment, and from early life I knew I would some day follow a career related to biology. I assumed, and my family assumed, that I would also become a physician and eventually take over my father's practice. But I saw his life as one of frustration and drudgery. My father had specialized training. However, he did not receive enough referrals to enable him to make a living at his specialty. He depended almost entirely on general practice. Furthermore, racial attitudes in the 30's and 40's made it difficult for him to obtain the privilege of admitting patients to hospitals. I eventually realized that I did not want to duplicate his experience. My family was initially disappointed, but after years of explaining that my studying zoology did not mean I wanted to clean out cages in a zoo, they accepted the idea that I was interested in the theory and principles of how animals carry out certain functions, particularly movement.

"The greatest satisfaction has come from doing novel experiments and deciding which results help to clarify significant problems."

Birthplace
Brooklyn, New York

Education
B.A., Cornell University, 1958, Zoology
M.A., Columbia University, 1961, Zoology
Ph.D., New York University, 1966, Biology

Present Position
Professor of Physiology and Pharmacology, Mayo Medical School and University of Minnesota

Honors
Established Investigator, American Heart Association (1974-1979)
Postdoctoral Rehabilitation Research Fellow in England (1967-1969)

The greatest satisfaction has come from doing novel experiments and deciding which results help to clarify significant problems. The feeling is probably equivalent to that which a painter or composer feels after creating something both unique and expressive.

Job opportunities in academic environments are presently scarce for those lacking experience in general chemistry, physics, mathematics, or computer science in addition to a special area of biological science. If the predictions about medicine for the next decade are correct (namely: (1) students will have increasing difficulty financing their education; (2) medical school enrollments will decline; (3) applicants to medical school will decrease to fewer than two applicants for each position; (4) disadvantaged minority students will choose professions other than medicine; pharmaceutical houses rather than medical schools will probably employ more of those who still choose to study pharmacology.

If one thinks in terms of plans for a career rather than a job, and if biological research seems stimulating and challenging, financial security should become a secondary factor in making a choice. The enthusiasm that the individual brings to the performance of a particular job will be most important. The financial worth assigned to the job will usually follow a job of value done well. Pharmacology will continue to play a vital role in all aspects of medical practice. Drugs will continue to be major tools used in preventing disease, relieving suffering, and assisting adaptation to impairments. All areas of medicine presently have a critical need for new therapies which shows no signs of becoming satisfied in the foreseeable future. The value that society has assigned to the function of a pharmacologist will of necessity remain high.

What is... PHYSICS

Physicists and astronomers study the structure of matter. By doing experiments and theoreticall calculations they try to learn the rules that govern how the basic particles of nature behave and how they are assembled into more complex forms. They study atoms and their nuclei, the solids, liquids and gases that surround us, the earth, the stars and the origin and form of the Universe itself. Physicists and astronomers now study phenomena at temperatures as low as tiny fractions of a degree above the absolute zero, to as high as many millions of degrees in the centers of stars. They use equipment too small to see except with microscopes, as well as huge accelerators miles in diameter. Since physics is the most fundamental of the sciences, physicists and astronomers work at the frontier of knowledge; their training also prepares them to enter new areas of research that arise and to contribute to society through the application of their ideas. Radio and television, atomic energy, computers, and tracers for medical diagnosis are all based on the discoveries of earlier generations of physicists.

Columbia launch, STS-3, March 22, 1982, Cape Canaveral, Florida

Homer A. Neal

High Energy Physics, Science Administration

Birthplace
Franklin, Kentucky

Education
B.S., Indiana University, 1961, Physics
M.S., University of Michigan, 1963, Physics
Ph.D., University of Michigan, 1966, Physics

Present Position
Provost and Professor of Physics, State University of New York — Stony Brook

Honors
Member, National Science Board (1980-present)
John Simon Guggenheim Fellow, Stanford University (1980-1981)
Invited Visit, Chinese Academy of Sciences, Peking, People's Republic of China (1979)
Recipient, Indiana University Physics Department Outstanding Teacher Award (1975)
Invited Visit, Russian Institute for High Energy Physics, Serpukhov, USSR (1971)

I am pleased to have this special opportunity to address minority high school students across the country who at this time are contemplating their general career choices. My message to you will be quite blunt: regardless of what other options you are considering you should also carefully consider a career in science or engineering. I advise you to do this not because I have a bias against other areas of study, but because over the decades an extremely unhealthy situation has developed in our country. Minority students have, for a variety of reasons, and none of which should have existed, generally avoided careers in science, leading us to current circumstances where there is a dearth of minority graduate students and professionals in the very areas of human endeavor that are likely to be the most exciting, challenging, and rewarding ones in the decades ahead.

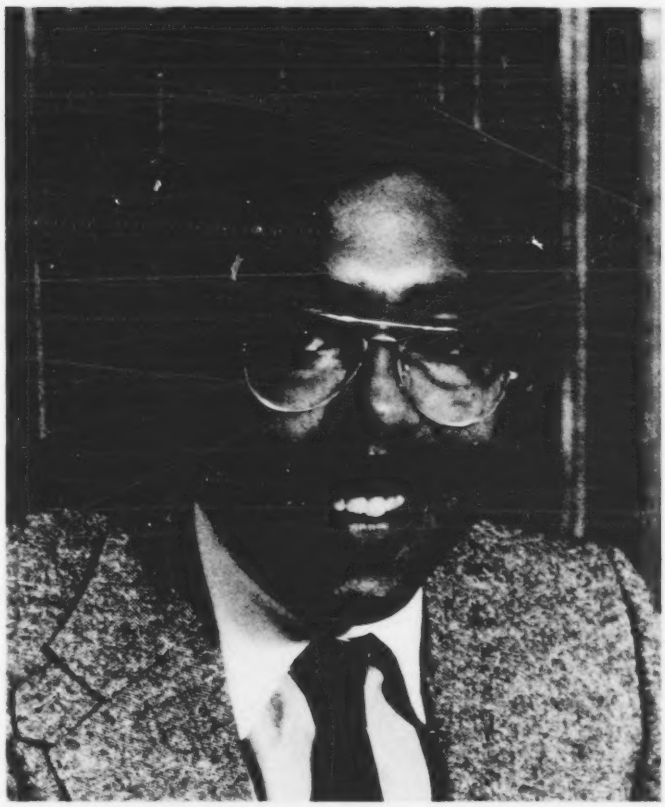
The small numbers of minority scientists and engineers today could be a source of dismay to many of you having an interest in pursuing careers in these areas; do not let it be. Rather, you should view the current situation as one that should encourage you to take advantage of a unique opportunity to pursue studies of your interest in an environment where those of you who are successful will have virtually unlimited occupational choices and options for personal fulfillment in the advancement of science and in serving society.

> *"The next moment is always one in which one's efforts might lead to the solution of problems of enormous importance."*

In my own career there have been many points at which I had to make one choice or another that greatly influenced subsequent phases of my life. None of these, however, was as important as my choice to pursue a career in physics. This selection literally permitted me to merge forever what would have been my hobby with what became my job. To be prepared to inquire into the most intricate details of the structure of matter with techniques that may have never been used by anyone before represents a challenge that continually makes life exceptionally enjoyable. The next moment is always one in which one's efforts might lead to the solution of problems of enormous importance. This attraction exists for all fields of science and engineering.

Walter E. Massey

Physics of Quantum Liquids and Solids, Science Administration



Birthplace
Hattiesburg, Mississippi

Education
B.S., Morehouse College, 1958, Physics and Mathematics
M.A., Washington University, 1966, Physics
Ph.D., Washington University, 1966, Physics

Present Position
Professor of Physics and Vice-President for Research, The University of Chicago and Director, Argonne National Laboratory

Honors
Board of Trustees, Brown University
Councillor, American Physical Society
Board of Directors, AAAS

I became interested in science as a result of an early interest in mathematics. During my first year at Morehouse College in Atlanta, I was fortunate to have an excellent physics professor. Not having been exposed to physics in high school, the area was a complete surprise to me. I learned it was a field in which one could apply mathematics to phenomena in the real world. Physics has proven to be a challenging profession, but a rewarding one as well. At one time in college, I thought I would become a jazz musician. I have found that much of the creative energy and personal

"At one time in college, I thought I would become a jazz musician."

rewards that one obtains in fields such as music and art can be found in scientific research.

BELOW
Operators at the control desk of the superconducting cyclotron at the National Superconducting Cyclotron Laboratory directing a high energy beam of carbon nuclei onto a target. Physicists use such beams to study the disintegration of atomic nuclei.

Being involved in science has also allowed me to grow in other ways. The rigorous training in quantitative thinking, as well as the sharpening of the intuition, have proved to be useful to me in a variety of positions, from the Dean of the College at Brown University to Director of Argonne National Laboratory and Vice-President for Research at the University of Chicago.

I believe that every student, for that matter every person, would enjoy and profit from studying science and mathematics, whether or not he or she intends to pursue a career in one of those fields. I am very interested in finding ways to increase the number of students taking such subjects, and also to encourage scientists and mathematicians to devote more time to working with and teaching non-science students. Science, and physics in particular, can be fun, personally rewarding, and lead to a socially fulfilling career.

Michael Martin Nieto

Theoretical Physics

Birthplace
Los Angeles, California

Education
B.A., University of California, Riverside, 1961, Physics
Ph.D., Cornell University, 1966, Physics

Present Position
Staff Member of Theoretical Division, Los Alamos National Laboratory

Honors
Phi Beta Kappa Alumni (1980)
Honorable Mention, Gravity Research Foundation Award (1973, 1980)
NSF Graduate Fellow (1961-1966)

What motivated me to go into physics came from a desire, early on, to be a "Renaissance Man." I wanted to understand as much as possible about as much as possible, and it all had to be self-consistent. Physics was the field where I could not be an amateur and comprehend deeply.

As a theoretical physicist, you are trying to understand and describe the laws of nature and their effects in certain situations. But it is *not* done as you learn it from textbooks. It is not revealed in a logical way, A implies B implies C. That is how you describe it to others *after* you understand it. Real physics is a creative art. The mathematics is the precise language you must use to describe your creation, but the big leaps are intuitive. Most of your professional life you feel somewhat stupid and lonely, because you do not understand what you are doing. When you do understand, then you are almost done. Your greatest joys are those of an explorer or an artist, when you discover something, no matter how small, that no one has before.

The first words I would say to a minority student are words I would say to anyone: If you go into research science, do it because you love it and are good at it. One of the great keys to life is to find out what you are good at among those things you like.

Then, if you love it and can do it, realize that, as in any field of activity, there are two main aspects. The first is to be a "professional," the second is to be creative. The first means hard work, the second means knowing where to leap — and perhaps having the courage to do so.

The following things are true for all students, but more specifically for minority students: (1) Don't look for discrimination everywhere, because if you look for it you will find it. You will have enough real problems without adding to them. (2) Don't expect the discrimination you run into to be the obvious red-neck variety. Academia is too sophisticated for that. Your battles will probably be more subtle, cultural forms of discrimination. It may boil down to the mu.ky question of personal "style."

I claim that there are differences among physicists (1) who would harm me because I am Mexican, (2) who would harm me because they would harm anyone in their way, and (3) who just don't like me. Everyone runs into people of the second and third types. As a minority you will also run into persons of the first type. You must learn how to differentiate among them and not confuse them.

"Your greatest joys are those of an explorer or an artist, when you discover something, no matter how small, that no one has before."

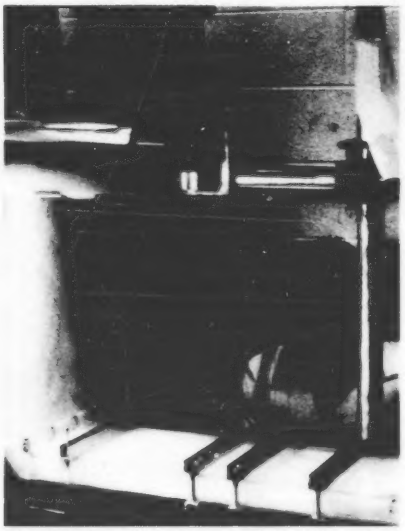
Finally, there is the question of special help and for how long. As a minority student you may indeed need special help. If you do, you must realize it. But you also must realize that the goal is to reach the point where you no longer need it, the point where you can fly on your own. My goal *never* was to be a good Mexican physicist (translation —

Eugene Tademaru

Electrodynamics of Pulsars

pretty good for a Mexican kid). My goal was to be a good physicist, who is Mexican.

Get to be your best. If you are one of those who will not be as good as you could have been because of a lack of training in youth (such as American soccer players or European basketball players), do not let the bitterness overwhelm you. You would then lose much of what you have gained, and the "bad guys" would win.



View into the multistory structure that will house the superconducting cyclotron at the National Superconducting Cyclotron Laboratory; this particle accelerator will be used to probe the ultimate structure of the atomic nucleus.

Birthplace
Amache, Colorado

Education
B.S., University of Illinois, 1964, Engineering Physics
Ph.D., University of Chicago, 1969, Physics

Present Position
Associate Professor of Astronomy and Physics, University of Massachusetts at Amherst

Honors
Fannie and John Hertz Foundation Fellowship (1968)

The workings of the universe have long been of interest to me and continue to motivate my current studies. It was chance or circumstances, however, that led or allowed me to pursue my present occupation. Being a minority I was taught from an early age that an education was vital to acceptance and success in American society. To this end, I was pragmatic and studied hard in high school to be able to go to college and to obtain a profession. My initial goal was an engineering degree, because in those fields good jobs were available and individual merit could be more objectively given independent of racial background. In college, my more fundamental interests were nutured, which led me to study the most basic of the sciences, physics.

In graduate school, my quest for some understanding of the universe became a way of life. Although my financial rewards are not great, I find a teacher's profession to be rewarding, because it allows not only the transmission of knowledge, but also the continuous learning of knowledge.

I must caution future scientists to realize that college level positions are rare and without hard work and luck almost impossible to obtain, but the life style is worth the effort. Further, although academic societies are not totally free of racial discrimination, they are generally the most liberal and allow minorities many opportunities to advance on their own merit.

"My quest for some understanding of the universe became a way of life."

What is... PHYSIOLOGY

Physiologists attempt to explain the function of the organism by examining its parts which are organized into cells, organs and systems. Most often an individual specializing in physiology will emphasize one of the systems such as cardiovascular, respiratory, renal, nervous, gastrointestinal, endocrine, or reproductive. There are those who prefer to study a particular organ of a system, for instance, the heart, stomach, or pancreas. Some physiologists emphasize the functioning of the cell or cell parts like mitochondria, microtubules, cell membranes or other organelles. The overall goal is to discover new information and to integrate knowledge into the previous discoveries which have been made. To accomplish this one may study many different organisms such as fish, reptiles, birds, or mammals including humans. Examination of body functions may be performed under normal resting situations but also unique insights may occur while observing organisms performing exercise or during times that a disorder or disease is present such as hypertension, diabetes, cancer, or many other conditions.

Electron micrograph of a nerve; each oval type structure is an axon.

Sarah D. Gray

The Cardiovascular System and Hypertension

Birthplace
Newark, New Jersey

Education
B.S., Barnard College, 1956, Zoology
M.S., New York University, 1960, Biology
Ph.D., University of California, San Francisco, 1966, Physiology

Present Position
Professor of Physiology, University of California, Davis

Honors
Sigma Xi
Les Femmes du Cour Award for Outstanding Research (1981)
Wellcome Research Travel Grant to England (1980)
Mary McLeod Bethune Recognition Award in Science, of the National Council of Negro Women (1978)
APS Circulation Group Certificate (1978)
National Research Council Travel Grant to India (1974)

I attended an excellent high school in Montclair, New Jersey, which had an interested and dedicated faculty who encouraged all talented students, no matter what their ethnic backgrounds, to prepare for college and eventual professional or graduate training. This may have been due to the fact that a large number of them had master's degrees. In such a supportive atmosphere I developed interests in many diverse subjects, but I liked biology classes and field trips most of all. During my first two college years, I enrolled in many science courses because of my interest in biology, but I also took courses in history, political science, literature and languages, which I enjoyed and considered as possible majors. By the end of my sophomore year I had taken zoology, chemistry (inorganic and analytical) and mathematics (trigonometry, analytical geometry, and calculus) and I finally decided to major in zoology, with an eventual goal of graduate study in some biomedical field. Several professors suggested that I seriously consider going to medical school, but I decided that my interests were more in the laboratory than in patient care.

Upon graduation I took a job as a research technician in a laboratory engaged in microcirculatory studies (function and control of the smallest blood vessels) while I worked part-time on a master's degree. I found that experience quite rewarding, but I also came to realize during that period that I would need more training in order to have a real sense of personal accomplishment and fulfillment. So, after completing that degree I moved to the west coast and entered in a Ph.D. program in physiology, with an emphasis in the cardiovascular area. Even after that degree, however, I realized that it would be necessary to take postgraduate training to gain more experience with a wide range of research techniques, so I spent a year abroad doing research in a cardiovascular laboratory in Sweden, and then returned to the U.S. for a second postdoctoral year at Duke University Medical School. After many long years of training, both in the classroom and in the laboratory, I finally took my first academic job teaching cardiovascular physiology and doing research in microcirculation.

"I liked biology classes and field trips most of all."

In thinking back over my career, I suppose the people who probably had the greatest influence on my career choice as research scientist were my parents who continually encouraged me to pursue any career that interested me ("you can do anything you set your mind to"), my biology teachers in high school and college who opened up the fascinating world of biology for me, and my first employer who introduced me to the wonders of the microcirculation, and who set an example as the dedicated scientist who thoroughly enjoyed the research laboratory.

Credits

The editors are grateful to the scientists and engineers who have written about their careers and have given substance to this book, and to the science department heads at Michigan State University, who made the initial contacts with these scientists. We also wish to thank the astronauts, Drs. Ride, Bluford, and Chang-Diaz, for taking time from their busy schedules for our interviews and Dr. John Lawrence of the Johnson Space Center in Houston for arranging these interviews. Ms. Paula Q. Hall of the American Association for the Advancement of Science was helpful in providing resources information and was encouraging about this project. We also thank Dr. Iris Weiss of The Research Triangle Institute for her helpful advice, resource material and written contributions and Dr. Nancy Kreinberg of The Lawrence Hall of Science for advice and encouragement. Dr. Ciriaco Gonzales of the NIH Minority Biomedical Research Support Program was understanding and supportive at a critical point in fund-raising, for which we are grateful. In addition, we wish to thank Perry Clark for supplying most of the photographs of laboratory scenes. Finally, we want especially to acknowledge the guidance and advice of Drs. James Hamilton and Diana Marinez of Michigan State University, who gave generously of their time and expertise in the last stages of development of the text for this book. We also thank Stephen Rayburn for budget management assistance. Manuscript copy and editorial assistance were kindly provided by Ms. Susan Leavitt and Ms. Theresa Fillwock.

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